New Haven-Hartford-Springfield High Speed Rail Program

Wallingford, Meriden and Berlin Stations Final (100%) Design Review Submission Specifications and Special Provisions

STATE PROJECT NUMBER 170-3155

Prepared by

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December, 2013

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Note: This index has been prepared for the convenience of those using this contract with the sole express purpose of locating quickly the information contained herein; and no claims shall arise due to omissions, additions, deletions, etc., as this index shall not be considered part of the contract.

** INDICATES NOTICE TO CONTRACTOR, SECTION OR SPECIAL PROVISION NOT INCLUDED IN THIS PACKAGE. THESE ARE TO BE INCLUDED, AS DETERMINED, BY CTDOT CONTRACTS AND/OR ENVIRONMENTAL COMPLIANCE.*

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PERMITS AND/OR PERMIT APPLICATIONS

DATE: 1/22/2014
FEDERAL AID PROJECT NO.: FR-HSR-0125-12-01-00
STATE PROJECT NO.: 170-3155/107-158

Construction of new railroad stations in the Town(s)/City of Wallingford, Meriden and Berlin

Town of Wallingford, City of Meriden, Town of Berlin
Federal Aid Project No. FR-HSR-0125-12-01-00

The State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges and Incidental Construction, Form 816, 2004, as revised by the Supplemental Specifications dated July 2013 (otherwise referred to collectively as "ConnDOT Form 816") is hereby made part of this contract, as modified by the Special Provisions contained herein. . The State of Connecticut Department of Transportation's "Construction Contract Bidding and Award Manual" ("Manual"), May 14, 2010 edition or latest issue, is hereby made part of this contract. If the provisions of this Manual conflict with provisions of other Department documents (not including statutes or regulations), the provisions of the Manual will govern. The Manual is available upon request from the Transportation Manager of Contracts. The Special Provisions relate in particular to the **Wallingford Railroad Station, the Meriden Railroad Station and the Berlin Railroad Station** in the Town(s)/City of **Wallingford, Meriden and Berlin**.

CONTRACT TIME AND LIQUIDATED DAMAGES

Seven Hundred and Forty (740) calendar days will be allowed for completion of the work on this project and the liquidated damages charge to apply will be Dollars ($3,600) per calendar day.

NOTICE TO CONTRACTOR – PROJECT DESCRIPTION (ALL STATIONS)

The Project consists of new and/or upgraded railroad stations located in Wallingford, Meriden and Berlin, Connecticut as shown and described in the Contract.

The project will construct stair towers, elevators and pedestrian bridges as well as approximately 500-foot long, partially covered platforms on property owned by Amtrak and/or owned or recently acquired by the Department of Transportation. Surface parking lots will be provided at each station and will accommodate 221 vehicles in Wallingford, 79 vehicles in Meriden, and 218 vehicles in Berlin. The stair towers include a waiting area and mechanical, electrical, communications and storage rooms. The pedestrian bridges will provide a track crossing compliant with the Americans with Disabilities Act via elevators and stair towers. The platforms will include steel canopies over a portion of their length.

Building work for the proposed facility consists of new east and west side platforms and canopies, new elevator/stair tower assemblies, new handicap-accessible ramps and stair assemblies, new pedestrian overpasses and associated sitework.

The platform assemblies will consist of cast-in-place concrete spread footings, foundation walls and T-walls. A precast concrete beam will sit on the T-walls and support platform. The platform surface will consist of precast concrete planks covered with a microsilica topping applied after installation. A hydronic snow-melt system will be incorporated into the microsilica topping and platform planks and run back to a centralized snow-melt mechanical room located on the back of each platform. Steel canopy frames and guardrails will be shop-fabricated and shop painted with a high-performance coating system.

The stair tower/elevator assemblies will be shop-fabricated and shop painted with the final exterior brick, metal cladding and windows applied after field assembly. Once the stair/elevator assemblies are completed, the pedestrian overpass will be assembled from several shop-fabricated lengths and hoisted into place. Final finishes will be completed after the overpass is in place. Note, the overpass will be finished with a shop-applied thermal spray metalized coating and a topcoat to prolong required maintenance. The elevator assemblies consist of a machine room-less type elevator and a heated/vented control closet on the second floor. Elevator shafts will not be conditioned.

Lighting, fire alarms and CCTV security cameras are included on both the platforms and in the stair tower/elevator assemblies.

A complete package of wayfinding, regulatory, and informational signs are also included as part of the overall station packages. Variable message signs and PA systems are also included.

Site work associated with the new facilities consist of excavation and grading work to accommodate the station components; removal and disposal of existing pavement, foundations and retaining walls, re-grading of the site for storm runoff; installation of site retaining walls;

installation of drainage structures; installation of new pavement; installation of earth retaining structures, installation of exterior stairs and walkways, curbing, fencing, landscaping, site signage, line striping, and exterior site lighting.

Also included in this project is the rehabilitation of the existing historic railroad station in Berlin. This includes rehabilitating the existing structure to restore its historical character and structural integrity. Major station building improvements related to the existing structure include: restoration of the load bearing masonry walls; rehabilitation of the wood roof and flooring; replacement of the exterior windows and doors; upgrades to the electrical, plumbing and HVAC systems; restoration/preservation of the original interior details; and restoration of the façade and exterior architectural details. The restored interior will accommodate an accessible ticket office/waiting area and upgraded handicap-accessible restrooms.

Environmental work associated with this facility consists includes work with polluted soils and groundwater, as further specified in the NOTICE TO CONTRACTOR – ENVIRONMENTAL INVESTIGATIONS.

NOTICE TO CONTRACTOR – STATION OPERATION

The Contractor is reminded that in Meriden and Berlin there shall be no interruption of station services during construction. The Contractor is responsible for providing a safe, accessible, well marked route for passengers to reach any temporary facilities and all platforms at all times, and for maintaining any temporary structures so that they remain free from hazards. The Contractor shall schedule work that will require closure of a platform during night hours, after station operations have ceased. The Contractor shall put in place temporary barricades and safety devices, as required, to return the entire platform to operation for the following morning. For further guidance refer to NOTICE TO CONTRACTOR – LIMITATION OF OPERATIONS and to Section 1.08 – Prosecution and Progress.

NOTICE TO CONTRACTOR – LIMITED SPACE AND AVAILABILITY OF PARKING

In order to maintain the maximum number of parking spaces available to commuters at the active stations in Meriden and Berlin, the Contractor shall restrict its operations to the areas shown on the Contract Plans. The Contractor will not be allowed to use any of the available parking spaces for storage of equipment or materials. Further, the Contractor must provide parking spaces for its employees, the employees of its subcontractors, and the Engineer and its employees within the staging area, outside of the limits of operation of the active stations.

NOTICE TO CONTRACTOR – MEASUREMENT AND PAYMENT

This Project is being bid with both lump sum and unit price items. The bid items include unit price and lump sum items which are IN ADDITION TO the four (4) Major Lump Sum Items (MLSI), of the Project, as follows:

Item No. 0065321A – Rail Facility Upgrade Site No. 1; proposed Berlin station
Item No. 0065322A – Rail Facility Upgrade Site No. 2; rehabilitation of the existing historic Berlin railroad station
Item No. 0063523A – Rail Facility Upgrade Site No. 3; proposed Meriden station
Item No. 0063524A – Rail Facility Upgrade Site No. 4; proposed Wallingford station

These separate items will be measured for payment on a unit price or lump sum basis (whichever is applicable) for which a separate bid price is required, at the quantities as indicated in the Bid Proposal Form.

Standard Form 816 Items are referenced by their standard item numbers. Refer to the applicable article of Form 816 for the requirements for these items. Special Provisions included in this Contract are referenced by their item number followed by an "A" suffix. Refer to the Special Provisions contained within this Contract for requirements for these items.

All work depicted on the Contract Plans and described in the Contract Specifications, including mobilization, is included in the MLSI of the Project, with the exception of the unit price or other lump sum items listed on the Bid Proposal Form. Any work that is outside the limits stated under “Method of Measurement” and “Basis of Payment” for a specific item, other than the MLSI, but is shown on the Contract Plans or described in the Contract Specifications, is included in the MLSI. Any work that is incidental to an item which is not specifically described or included in the item, but which is required for performance and completion of the work required under the Contract, is included in the MLSI.

Vertical Construction Limits

The vertical construction limits are defined as five (5) feet outside of the vertical projection of the edges of the platform, stair and ramp assemblies and five (5) feet (horizontally) outside the face of footing of stair tower, shelter and snow-melt mechanical room building walls. The following unit price items will only be measured for payment up to the vertical construction limits:

Item No. 0202000, “Earth Excavation”
Item No. 0202100, “Rock Excavation”
Item No. 0205001A, “Trench Excavation 0’-4’ Deep”
Item No. 0205003A, “Trench Excavation 0’-10’ Deep”
Item No. 0207004, “Borrow”
Item No. 0651001A, “Bedding Material”
Item No. 0651743A, “6” Polyvinyl Chloride Pipe”

Item No. 0651745, “8” Polyvinyl Chloride Pipe”
Item No. 0651746, “12” Polyvinyl Chloride Pipe”
Item No. 0651747, “15” Polyvinyl Chloride Pipe”
Item No. 0651424, “6” HDPE Pipe – Perforated (Smooth Interior)”
Item No. 0651427, “12” HDPE Pipe – Perforated (Smooth Interior)”
Item No. 0651___, “6” PVC Pipe – Top Half Perforated”
Item No. 0651___, “8” PVC Pipe – Top Half Perforated”

Item No. 1208906, “Sign Face - Sheet Aluminum - Bright Wide Angle Retroreflective Sheeting”
Item No. 1208928, “Sign Face – Sheet Aluminum (Type III Reflective Sheeting)”

Work associated with these items located within the vertical construction limits (as defined above) is included in the MLSI.

The following unit price items will be measured for payment, whether or not they are enclosed within the vertical construction limits:

Item No. 0000985A, “Track Monitoring”
Item No. 0209001, “Formation of Subgrade”
Item No. 0212000, “Subbase”
Item No. 0213050, “Bank Run Gravel”
Item No. 0304002, “Processed Aggregate Base”
Item No. 0714026A, “Temporary Sheet Piling (Railroad)”
Item No. 0715021A, “Sheet Piling Material Left In Place (Railroad)”
Item No. 0728020, “Stone Ballast”
Item No. 0811001 “Concrete Curbing”
Item No. 0814002, “Reset Granite Stone Curbing”
Item No. 0901003A, “Steel Bollard”
Item No. 0913041, “8’ Chain Link Fence”
Item No. 0921001A, “Concrete Sidewalk”
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Item No. 1210101A, “4” White Epoxy Resin Pavement Markings”
Item No. 1210102A, “4” Yellow Epoxy Resin Pavement Markings”
Item No. 1210105, “Epoxy Resin Pavement Markings, Symbols and Legends”
Item No. 1210106A, “12” White Epoxy Resin Pavement Markings”

Platform/Site Amenities

There will be no separate payment for platform/site amenities, including, but not limited to benches, trash receptacles, bus shelters, bicycle shelters, bicycle stands, etc. The cost of these

site amenities, including any hardware and any required excavation and backfill, is included in the MLSI.

Signage

There will be no separate payment for signage, including but not limited to station identification signs, kiosks, accessible route signage, tactile signage, schedule holders and other pedestrian wayfinding signs. The cost of these signs, including any hardware, footings, installation and any required excavation and backfill is included in the MLSI. Vehicular signage, including directional signage, stop signs and parking signs, including any posts, hardware, footings, installation, and any required excavation and backfill, will be measured for payment on a unit price basis for which a separate bid price is required at the quantities as indicated in the Bid Proposal Form.

Canopy Power

There will be no separate payment for the installation of conduit and cable for the canopy power and communications for lighting, PIDs, trackside phones and/or the public address system. The cost of the conduits, cables, hardware, handholes, junction boxes and/or vaults, and any required excavation and backfill, is included in the MLSI.

Electrical Pads and Bases

There will be no separate payment for concrete associated with the fabrication and installation of light pole bases, equipment pads, or for protection of electrical conduit and service entrances. The cost of concrete, including reinforcing, spacers, formwork, excavation and backfill, is included in the MLSI.

Electrical

There will be no separate payment for excavation and backfill associated with the installation of site electrical items including, but not limited to; exterior lighting; electrical service, including service to the building; video monitoring equipment; internally lit signs; illuminated egress signs; fire alarm components; train approach message boards; emergency kiosks; communication cable and conduit; or any other site electrical cable, conduit, or service connection component. The cost of excavation for all site electrical items is included in the MLSI.

Water Connections

There will be no separate payment for the excavation, backfill and materials required for, or the installation of, the hose spigot, hydrant and water line for service to the platforms. All associated material and installation costs for the water service are included in the MLSI.

Railroad Grounding/Bonding Connections

There will be no separate payment for necessary components to complete the station grounding and bonding connections, including associated excavation and backfill. The costs for all grounding items are included in the MLSI.

Station Downspouts, Leaders, and Splash Blocks

There will be no separate payment for the necessary components to complete the drainage systems from the vertical construction to the discharge of the associated runoff. Downspouts, leaders, boots, splash blocks, incidental items, and all necessary excavation and backfill are included in the MLSI.

Revenue Collection System (RCS)

The RCS on this project is a sole source item. As such, the furnishing of the RCS at each of the site surface parking lots is covered under the respective Form 816 lump sum item as follows:

Item No. 0063___A – Revenue Collection System (Site No. 1); proposed Berlin station
Item No. 0063___A – Revenue Collection System (Site No. 3); proposed Meriden station
Item No. 0063___A – Revenue Collection System (Site No. 4); proposed Wallingford station

The cost of installing the RCS as well as furnishing and installing items incidental to the RCS are included in the MLSI. These items include, but are not limited to, conduit, wiring, splice boxes, RCS signage, sign posts, pavement markings for stall numbering, "back office" hardware, concrete, reinforcing steel, crushed stone, excavation, backfill, bollards and handholes.

NOTICE TO CONTRACTOR – FORM 816 REFERENCES ON STANDARD DRAWINGS

The Contract includes standard Connecticut Department of Transportation drawings with material and pay limit references to Form 816. For work shown on these drawings that is included under the Major Lump Sum Item (MLSI) for the Project, the Contractor shall disregard these references within the Vertical Construction Limits which are defined in Notice to Contractor – Measurement and Payment. Concrete shall comply with the requirements of CSI Specification Section 033000 under the MLSI.

Pay limits for unit price and lump sum items other than the MLSI shall be in accordance with Method of Measurement (Part 4), and Basis of Payment (Part 5) of the appropriate special provision section. Concrete for unit price items other than the MLSI shall be in accordance with Form 816, unless specifically noted otherwise.

NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS

The Contractor is hereby advised that it is the expressed intent of the Department that no materials containing asbestos of any kind or amount be installed in Department facilities as a result of any work being performed under this Contract.

For all materials that have a probability of containing asbestos, the Contractor shall provide a certification letter on the manufacturer's letterhead along with the regular submittal package to prove that asbestos is not contained in the materials. These materials will not be approved without the required manufacturer certification letter. The manufacturer certification letter shall be formatted in the following manner:

[Addressed to:] Commissioner of Transportation
Department of Transportation
P.O. Box 317546
Newington, Connecticut 06131-7546

Project Title and Number

[We] hereby certify that all materials manufactured by [Insert Manufacturer Name] are asbestos-free.

[Signature:] [Name of authorized signatory]
[Title]

The Contractor shall submit manufacturer certification letters for all materials specified in the following Contract provisions (including CSI-formatted specifications contained within a particular special provision):

1. Division 7 Section 071113, "Bituminous Dampproofing."
2. Division 7 Section 072100, "Thermal Insulation."
3. Division 7 Section 074213.19, "Insulated Metal Wall Panels."
4. Division 7 Section 076200, "Sheet Metal Flashing and Trim."
5. Division 7 Section 079200, "Joint Sealants"
6. Division 8 Section 087100, "Door Hardware."
7. Division 8 Section 088000, "Glazing."
8. Division 9 Section 092116.23, "Gypsum Board Shaft Wall Assemblies"
9. Division 9 Section 093013, "Ceramic Tiling."
10. Division 9 Section 095113, "Acoustical Metal Pan Ceilings."
11. Division 22 Section 220000, "Plumbing"
12. Division 23 Section 230584, "Through Penetration Firestop Systems"
13. Division 23 Section 230713, "Duct Installation"
14. Division 23 Section 230716, "Equipment Insulation"

15. Division 23 Section 230719, “HVAC Piping Insulation”
16. Division 23 Section 235224, “Condensing Boilers”

The above list may not be all-inclusive and does not relieve the Contractor from its responsibility to provide manufacturer certification letters that are required under other Contract provisions. Furthermore, the Department may at any time require the Contractor to submit manufacturer certification letters proving that other materials do not contain asbestos.

Failure of the Contractor to provide the required documentation will result in the immediate removal of the material from the Project by the Contractor at its expense. The Contractor shall be responsible for all costs incurred as a result of such required action, and replacements thereof, in order to complete the Project.

Any asbestos containing material that is found to have been installed as a result of work performed under this Contract will be required to be removed by the Contractor at its expense as soon as such determination is made. The Contractor shall also replace the removed material with appropriate material that is in compliance with the Contract. The Contractor is also responsible to pay for any asbestos testing charges the Department incurred in order to prove that the material contains asbestos fibers. This obligation will extend throughout the one-year warranty period after the issuance of the Certificate of Compliance.

The Contractor shall complete and sign the attached certification form assuring the Department that no asbestos-containing materials have been used in the construction of this Project. This form shall be submitted prior to the Semi-Final Inspection. The Certificate of Compliance will not be issued without this completed and signed certification form.

CONTRACTOR CERTIFICATION:
RE/ ASBESTOS CONTENT OF MATERIALS

State of Connecticut
Department of Transportation
PO Box 317546
Newington, CT 06131-7546

1. Project Number: _____

2. Project Name: _____

3. Contractor Name: _____

4. This is to certify that I have read, understood, and complied with the terms and conditions identified under the "NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS" included in this Contract.

   I fully understand that it is the requirement of the Connecticut Department of Transportation that only materials that do not contain asbestos of any kind or amount are to be utilized in the construction of this Project.

   I therefore certify that, to the best of my knowledge, all materials installed under this Contract are asbestos-free.

   For the one-year warranty period after the issuance of the Certificate of Compliance, I agree to remove any asbestos-containing material identified by the Connecticut Department of Transportation and reinstall an approved, non-asbestos-containing material that is in compliance with the original Contract at no additional cost to the State.

5. Date of Certificate of Compliance: _____

6. Date of the Asbestos Certification: _____

7. Signature of Authorized Party Agreeing to the Terms & Conditions Identified Herein & as Further Stated in the Contract:

_____ _____
Signature Title

_____ _____
Printed Name Date

NOTICE TO CONTRACTOR – PLATFORM CONSTRUCTION

This project contains platform construction along new tracks. The new tracks are bing constructed under a separate contract and may, or may not, be completed prior to the commencement of construction for State Project No. 170-3155. The proposed track baselines are shown for informational purposes only and are in no way warranted to indicate the as-built conditions in the field. The Contractor shall verify the location of the track(s) via a field survey prior to the start of platform construction and shall notify the Engineer immediately of any discrepancies.

The Contractor is advised that the railroad platforms must be constructed to specific offset requirements as required by Amtrak. These requirements are shown on Amtrak Standard Track Plan 70050-G “Minumum Roadway Clearances” and in the contract plans.

If made available by the Department, the Contractor shall not rely on CADD files for the construction of the railroad platforms and items incidental thereto (including, but not limited to, the platform stem wall, t-walls, footings, etc.). At all times, the Contractor shall be bound by the horizontal and vertical offset controls noted in the Amtrak Standard Track Plan 70050-G and as shown on the plans. It is the Contractor’s responsibility to field verify the site conditions, and notify the Engineer of any discrepancies, prior to the start of the platform construction.

The Contractor shall bid the project accordingly.

NOTICE TO CONTRACTOR – LIMITATION OF CONTRACTOR OPERATIONS

The Contractor shall repair at its own expense any and all damage caused by construction operations to existing buildings unless said damage is scheduled as part of the Project work. The Contractor shall take all precautions necessary to protect the existing facilities and its occupants for the duration said facilities are to remain in operation.

During all times that the Project Site is occupied by the Engineer and Department personnel, the Contractor shall maintain the following utilities and services to the extent described to permit Department operations:

1. Electrical Service: The Contractor shall be responsible for paying all monthly electrical usage utility costs related to their construction field office.

2. Telephone Service: The Contractor shall be responsible for paying all monthly telephone utility usage costs related to their construction field office.

3. Sanitary Facilities: The Contractor is responsible for emptying the sanitary facilities at its expense.

The Contractor shall bid the Project accordingly.

NOTICE TO CONTRACTOR - RIGHTS OF WAY RESTRICTIONS

The Contractor is hereby advised that at the time of advertising for bids not all the property may be acquired by the State, certain residences and/or business establishments had not been vacated, and asbestos removal by others from buildings to be disposed of had not been completed. A complete listing of the affected properties and the anticipated dates that they will become available is hereinafter provided. The Contractor is further advised that limitations, as enumerated herein below, are imposed which may interfere with the physical construction of the project. Following are statements which will set forth the restrictions on the right of entrance to property and conditions governing construction of the project.

1. The Contractor shall not occupy properties that are unacquired, perform any work thereon, or inhibit access thereto until the properties have been acquired and right of possession has been obtained. If the Contractor is allowed to proceed with the physical construction of the project, no action will be taken that will result in unnecessary inconvenience such as the discontinuance of utilities, the prevention of ingress and egress to the property, or will result in disproportionate injury or any action coercive in nature to occupants of residences (businesses, farms, or non-profit organization) who have not yet moved from the right-of-way.

2. The Contractor shall notify property owners a minimum of 30 days in advance of any use of, or work on, any parcels noted as requiring an “Access Easement”, “Temporary Access Easement”, or “Construction Easement”.

3. In addition to the requirements of No. 2 above, the Contractor is notified that all work impacting the Catholic Charities, Inc. – Archdiocese of Hartford property (61 Colony Street in Meriden) must be completed within a 30-day period. The Contractor shall employ extra manpower, equipment and/or workshifts, including overtime and/or weekends, to complete the work in accordance with the specified time. The Contractor shall bid the project accordingly.

4. It should be anticipated that each of the properties listed herein may be considered to have an effect upon construction operations.

5. The Contractor shall be aware that extensions of time will be granted, if necessary, for delays in construction operations caused by continued occupancy of residences, properties being unacquired or asbestos abatement concluding beyond the estimated time period.

The following is a complete listing of properties which have not been acquired, vacated and asbestos abated as of **TBD** with the anticipated dates such properties will be acquired and/or vacated and abated.

***** LIST TO BE INCLUDED IN FUTURE SUBMISSION *****

NOTICE TO CONTRACTOR – UTILITY SERVICE CONNECTIONS [AND RELOCATIONS]

The **electric, telephone, gas, water (including fire protection), and sewer** services to the Project Site require service connections **to** the applicable utility company's facilities. Utility service connections **and** installations to the point of the utility service are included as shown and described within the Contract.

The Contractor is responsible for notifying the utility company prior to the need for the utility connection, and for coordinating the service connection **and/or relocation** requirements with the utility company. The Contractor shall coordinate with the following utility companies:

Town of Wallingford:

Electric:	Town of Wallingford Department of Public Utilities – Electric Division
Telephone:	AT&T Connecticut
Gas:	Yankee Gas Services Company
Water:	Town of Wallingford Department of Public Utilities – Water & Sewer
Sewer:	Town of Wallingford Department of Public Utilities – Water & Sewer

City of Meriden:

Electric:	Northeast Utilities Service Company
Telephone:	AT&T Connecticut
Gas:	Yankee Gas Services Company
Water:	City of Meriden Department of Public Works
Sewer:	City of Meriden Department of Public Works

Town of Berlin:

Electric:	Northeast Utilities Service Company
Telephone:	AT&T Connecticut
Gas:	Yankee Gas Services Company or Connecticut Natural Gas Corporation
Water:	Kensington Fire District
Sewer:	Town of Berlin Department of Public Works

Where known, utility company representatives are identified elsewhere within the Contract.

An allowance is included in the Contract to reimburse the affected utilities for the work required to install their facilities to the new/upgraded railroad stations. The Contractor shall include this allowance in its Contract bid. Refer to **Item #1700001A – Service Connections (Estimated Cost)** for additional information in this regard. The Contractor is responsible for coordinating this work with the utility company and for administrative requirements for reimbursing the utility company.

NOTICE TO CONTRACTOR – SUBMITTALS

The Contractor is hereby notified that submittals, including shop and working drawings, computations and calculations, catalog cuts, data sheets and all other materials the Contractor submits to ConnDOT shall be PREPARED AND SUBMITTED IN DIGITAL FORMAT. All correspondence including drawings submitted for review and/or approval, submittals, etc. will be transmitted by all parties in digital format, in accordance with the latest ConnDOT Policies and Procedures

Transmittal of Submittals: Unless otherwise stipulated, all submittals requiring review for conformance with the Contract shall be digitally transmitted to Michael Baker Engineering, Inc., ATTN: TBD, 500 Enterprise Drive, Suite 2B, Rocky Hill, Connecticut 06067

A transmittal letter shall be sent to Mr. Theodore H. Nezames, P.E., Transportation Principal Engineer, Facilities Design, Bureau of Engineering and Construction, Connecticut Department of Transportation, 2800 Berlin Turnpike, P.O. Box 317546, Newington, CT 06131-7546, Room 3405, ATTN: Mr. Eric Bergeron.

Copies of the transmittal letter shall be sent to the District 1A Administration Office, 700 State Street140, Suite 101, New Haven, CT 06511, Attention: Lynn Cichowski

Submittals requiring review for conformance with the Contract that shall be printed and submitted directly to the Assistant District Engineer in lieu of the Designer are listed below. Copies of the transmittal letters shall be sent to the Transportation Principal Engineer, Facilities Design.

Concrete Mix Design Certifications
Asphalt Mix Design Certifications
Erosion Control Plan and Materials
Demolition Plan
Disposal Plan
Welding (Welder) Certificates
Certified Test Reports, Material Certificates, etc. from Form 816 Standard Items (non “A” Items from Bid List)

Submittals requiring review for conformance with the Environmental Contract work shall be printed and hand delivered or sent by mail directly to Mr. Gregory Dorosh, Manager of Environmental Compliance, Bureau of Engineering and Construction, Connecticut Department of Transportation, 2800 Berlin Turnpike, P.O. Box 317546, Newington, CT 06131-7546, Room 3127. Copies of the transmittal letters shall be sent to the Transportation Principal Engineer, Facilities Design and to the Assistant District Engineer.

Health and Safety Plan
Disposal Plan and Site

Lead/Asbestos Abatement Plan

Submittal Preparation and Processing: The Contractor shall provide the Designer with complete submittal packages (Product Data, Shop Drawings, Samples, and Quality Assurance Submittals, as applicable) for individual elements of Project work for a concurrent review of all information. Incomplete submittal packages will be returned to the Contractor without being reviewed.

Unless digitally submitted as specified herein, the Contractor shall submit 9 copies of each required submittal for the Designer's review. The Contractor shall add 1 printed copy of the following CSI Sections for outside agency (FM Global) review:

***** Outside agency (FM Global) review TBD by CTDOT *****

Shop Drawings: Unless digitally submitted as specified herein, the Contractor shall submit 1 correctable translucent reproducible print and 8 blue- or black-line prints for the Designer's review. The Contractor shall add 1 printed blue- or black-line print for each of the above noted CSI Sections for outside agency review (TBD by CTDOT).

Samples: Where Samples are for selection of color, pattern, texture or similar characteristics from a range of choices, submit two (2) full sets of the standard and custom choices for the material or product. Where Samples illustrate assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics, submit one (1) sample (or set, if applicable).

Designer's Action: The Designer will digitally return submittals marked with action taken and corrections or modifications required.

Shop Drawings: The Designer will return shop drawings digitally. The digital copy shall be considered a "Record Document" and maintained as such.

Samples: The Designer will return one set of samples marked with the action taken. The set of samples shall be maintained at the Project site when returned.

Maintenance manuals and warranties will not be returned unless they are rejected.

NOTICE TO CONTRACTOR – EARLY SUBMITTALS

The Contractor is hereby advised that the Department has identified the potential need to order certain materials and equipment, and thereby submit certain submittals for approval early in the construction process to insure the Project is completed within the allowable Contract Time. Submittals shall be in accordance with Form 816 Article 1.20-1.05.02. The following items have been identified as possibly requiring early ordering thereby requiring early submission of shop drawings and product data, including color selection charts and samples:

Temporary Sheet Piling - Railroad
Precast Concrete Design Mix
Precast Concrete Shop Drawings
Architecturally-Exposed Structural Steel Framing
UPS Systems
PID/PA Head-End Equipment

The following items have been identified as possibly requiring early submission for purposes of project coordination and project work scheduling:

Selection of the Project Coordinator
Baseline Critical Path Schedule
Contractor's Submittal Schedule
Health and Safety Plan
Pedestrian Bridge Erection Plan (approval by Amtrak)
Snow Melt System Shop Drawings

The lists above are not intended to be all-inclusive and do not relieve the Contractor from coordinating the activities of its subcontractors and suppliers. The Contractor will not be permitted to perform any physical work on the Project without the approval of the required submittals. Failure to properly plan for long lead items within the Contract schedule will not be justification for additional construction time.

It is recommended that the Contractor identify early in the construction sequencing process the subcontractors and suppliers associated with long lead-time items and submit the appropriate shop drawings and supporting data, including color selection charts and samples, for review upon Notice to Proceed.

NOTICE TO CONTRACTOR – SOLE SOURCE PRODUCTS

For operational purposes, the Department has determined the need to sole source products specified in the following Contract provisions (including specific CSI-formatted Specifications contained within a particular Special Provision):

1. Revenue Collection System Site No. X, Form 816 Item No. 0063__XA
2. Passenger Information Display (PID) Systems, CSI Section 274216

No "Or Equals" will be permitted. Said products shall be installed only by their factory authorized installer or service representative. The Contractor shall bid the Project accordingly.

Rev. Date 12/9/13

NOTICE TO CONTRACTOR – FM GLOBAL SUBMITTALS

Copies of the following submittal(s) requiring FM Global review for conformance with the Contract shall be transmitted to the Designer in accordance with NOTICE TO CONTRACTOR- SUBMITTALS. Review of the following submittals may take up to 60 days in accordance with Form 816 Article 1.20-1.05.02.

1. FM Global Form 2688 *Application for Acceptance of Roofing Systems*

2. FM Global Property Loss Prevention Data Sheet 1-31 Metal Roofing Systems for the standing seam roof. Detailed drawings and calculations including the manufacturer and type of metal roof, insulation, purlins and bracing will accompany the Property Loss Prevention Data Sheet.

3. FM Global Form 85B, Contractor's Material and Test Certificate for underground piping should be completed and submitted to FM Global.

The above list may not be all-inclusive and does not relieve the Contractor from its responsibility to provide ConnDOT or AMTRAK other submittals for approval as may be required elsewhere in the Contract Drawings.

NOTICE TO CONTRACTOR – PRE-INSTALLATION MEETINGS

The Engineer will conduct a pre-installation meeting at the Project Site before each of the following construction activities:

1. Pre-demolition: Form 816 Article 1.20-1.08.03 – Prosecution of Work, subsection 4 – Selective Demolition
2. Rail Facility Upgrade Site No. 2, Form 816 Item No. 0063522A
3. Furnishing, Planting and Mulching Trees, Shrubs, Vines and Ground Cover Plants, Form 816 Item No. 0949003A
4. Cast-in-Place Concrete, CSI Section 033000
5. Precast Concrete, CSI Section 034100
6. Microsilica Concrete Overlay, CSI Section 035320
7. Brick Masonry, CSI Section 042113
8. Thermal Spray Metalizing and Sealing Coats, CSI Section 050310
9. Architecturally Exposed Structural Steel Framing, CSI Section 051213
10. Standing Seam Metal Roof Panels, CSI Section 074113.16
11. Glazed Aluminum Curtainwalls, CSI Section 084413
12. Tactile Warning Strip – Surface Applied, CSI Section 093050
13. Staining and Transparent Finishing, CSI Section 099300
14. Aluminum Wayfinding, Identification and Regulatory Sign Types, CSI Section 104250
15. Revenue Collection System, CSI Section 116000
16. Electric Traction Elevators, CSI Section 142100
17. Hydronic Snow Melt System, CSI Section 238316
18. Electrical and Communication Raceway/Conduit Systems, CSI Section 260533

The above list may not be all-inclusive and does not relieve the Contractor from its responsibility to provide pre-installation meetings that are required under other Contract provisions.

NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

General: The list of special provisions (including CSI-formatted specifications) in the Table below may not be all-inclusive and does not relieve the Contractor from its responsibility to provide spare parts, operation and maintenance manuals, training, and warranties that are required under other Contract provisions.

This Table will be forwarded to **Mr. Richard Jankovich, Office of Rails,** for concurrence prior to the Semi-Final Inspection.

Spare Parts: The Contractor shall deliver spare parts on products listed in the Table below to the Project Site.

Operation and Maintenance Manuals: Submit four (4) copies of each manual to the Designer. The Designer and **Mr. Richard Jankovich, Office of Rails,** will review the manuals for conformance to the Contract. The manuals will be processed in accordance with Form 816 Article 1.20-1.05.02, with three (3) copies being forwarded to **Mr. Richard Jankovich** and one (1) copy being sent to the Engineer.

Materials and Finishes Maintenance Manual: The Contractor shall provide complete information in the materials and finishes manual on products listed in the Table below.

Equipment and Systems Maintenance Manuals: The Contractor shall provide complete information in the equipment and systems manual on products listed in the Table below.

Training: The Contractor shall provide training on products listed in the Table below.

Warranties: Submit 4 copies of written warranties, including special warranties to the Designer. The Designer and **Mr. Richard Jankovich, Office of Rails,** will review the warranties for conformance to the Contract. The warranties will be processed in accordance with Form 816 Article 1.20-1.05.02, with three (3) copies being forwarded to **Mr. Richard Jankovich** and one (1) copy being sent to the Engineer.

The Contractor shall provide special warranties on products and installations listed in the Table below:

TABLE

Special Provision (including CSI-formatted Specifications)	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
Form 816 Item No. 0905___A	X			
Form 816 Item No. 0947003A	X	X		
CSI-Formatted Section 050310	X			
CSI-Formatted Section 074113.16	X			X
CSI-Formatted Section 074213.19	X			
CSI-Formatted Section 074243	X			X
CSI-Formatted Section 077100	X			
CSI-Formatted Section 079200	X			
CSI-Formatted Section 087100	X			
CSI-Formatted Section 088000	X			
CSI-Formatted Section 093050		X		X
CSI-Formatted Section 099610	X			
CSI-Formatted Section 104060	X			
CSI-Formatted Section 104070	X			
CSI-Formatted Section 104250	X			
CSI-Formatted Section 104260	X			
CSI-Formatted Section 116000	X	X	X	X
CSI-Formatted Section 142100	X			X
CSI-Formatted Section 220000	X		X	X
CSI-Formatted Section 230500	X			X
CSI-Formatted Section 230514	X		X	
CSI-Formatted Section 230593				X
CSI-Formatted Section 232123			X	X
CSI-Formatted Section 232500		X	X	X
CSI-Formatted Section 235224	X		X	
CSI-Formatted Section 238235	X			
CSI-Formatted Section 238240	X		X	X
CSI-Formatted Section 238316	X			X
CSI-Formatted Section 251000			X	X
CSI-Formatted Section 260500	X			
CSI-Formatted Section 260923	X		X	X
CSI-Formatted Section 262416	X	X		X
CSI-Formatted Section 262713		X		X
CSI-Formatted Section 262726				X

Special Provision (including CSI-formatted Specifications)	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
CSI-Formatted Section 263353	X		X	X
CSI-Formatted Section 264313	X			X
CSI-Formatted Section 265100		X		X
CSI-Formatted Section 265600		X		X
CSI-Formatted Section 266000	X			X
CSI-Formatted Section 247216				X
CSI-Formatted Section 275116				X
CSI-Formatted Section 282301	X		X	X

NOTICE TO CONTRACTOR – WORK ON RAILROAD PROPERTY

The Contractor acknowledges that work to be accomplished under this Contract is to be performed on Railroad territory, which consists of territory operated by National Railroad Passenger Corporation (AMTRAK). The Contractor's work must be accomplished simultaneously with ongoing daily Railroad operations. Such operations include, but are not limited to, the passage of trains, storage of trains, flagging, inspection, repair, construction, reconstruction, and maintenance of the railroad right-of-way and facilities.

The Contractor is advised that the Railroad controls all activities in the respective right-of-way, and the Department expects that these conditions may cause delays and possibly a complete suspension of construction activity. The Contractor shall consider normal Railroad operations and associated impacts to the construction schedule. The Contractor shall not be entitled to time extensions for delays associated with normal Railroad operations. If the Contractor is delayed or suspended in the completion of the work by atypical railroad operations including, but not limited to, activities associated with a derailment, major track failure, or extended power outage, the Contractor will be entitled to a time extension for every day that he can demonstrate that the delays affected the completion date of the Contract. This extension of time will be considered non-compensable and the Contractor will not be entitled to any additional compensation for damages incurred for all direct and indirect costs including, but not limited to, all delay and impact costs, and inefficiencies.

The Contractor shall be responsible for obtaining the "Temporary Permit to Enter Upon Property" included elsewhere in this Contract. The cost of obtaining this permit including the cost of complying with the Specifications attached to the permit (Insurance, Safety, Training, etc.) shall be included in the MLSI. The cost of Railroad Flag Protection necessary to complete the work shown in the Contract, as well as the cost of other work shown in the Contract to be performed by AMTRAK Forces, shall be paid directly by the State under separate Force Account Agreement.

The Contractor shall be responsible for the coordination of the work of its various subcontractors. The Contractor shall coordinate its operations with those of the Railroad Company in carrying out railroad force account.

The Contractor must make its own arrangements with the Railroad Company for the use of Railroad equipment or changes in Railroad facilities made solely to facilitate the Contractor's operations. The expense incurred by making such arrangements shall not be a part of this Contract.

Contractor Requirements for Work Affecting the Railroad

The Contractor shall be governed by AMTRAK EP3014 and the General Requirements and Covenants of the Contract.

1. All matters requiring Railroad Company approval or coordination shall be directed to:

Mr. Earl Watson III
Project Development Officer
National Railroad Passenger Corporation
30th Street Station, Mail Box Bo. 64
30th and Market Streets
Philadelphia, PA 19104
(215) 349-1393

2. In general, unless otherwise authorized by the Railroad, operations directly over or adjacent to the operating right-of-way will be performed during the following time periods:

Outage	Time
***** Outages and Times to be provided by PMT/Amtrak *****	

Temporary at-grade crossings across any tracks WILL be permitted. Provide a minimum of 30 calendar days advance notice for scheduling any work to be performed by AMTRAK forces.

***** CROSS TRACK ACCESS REQUESTED FOR CONSTRUCTION STAGING *****

All work involving rail, ties, and other track components on active tracks, unless specifically designated otherwise within the Contract, will be performed by AMTRAK employees.

Notes:

1. Single-track outages will be considered as requests are submitted. Additional track outages will be considered for approval as requested by the Contractor for the completion of work.

2. While every effort is made to accommodate the Project needs, the above track outages cannot be guaranteed at all times. Track outages are dependent on many circumstances; including weather, availability of protective personnel, conflicts with other projects and unforeseen operating problems. Therefore, no claims may be made against AMTRAK for delays due to unavailability of track outages. Further, outages are granted on the basis of what is deemed necessary for construction, not merely for the Contractor's convenience.

3. The hours shown for track outages are the times the track(s) will be out of service. These outage times do not represent the time the track(s) are available to the Contractor. Time needs to be allowed to take the track out of service.

4. Station area work shall be performed, and flag protection acquired, in accordance with AMTRAK Safety procedures.

5. AMTRAK employees, unless specifically designated otherwise within the Contract, will perform all work involving rail, ties, and other track components on all tracks (in service or out of service). The Contractor may not remove abandoned track (out of service) unless given prior written approval from the Engineer and AMTRAK.

6. Erection of the pedestrian bridge is to be performed on a XXXXX morning between the hours of XX:XX AM and XX:XX AM. During this erection operation, no tracks shall remain in service. AMTRAK shall have the authority to postpone this operation, at its sole discretion, because of weather or other condition or circumstance that may arise. Should postponement occur, the erection will be rescheduled to either the following day or a subsequent weekend. ***** Day(s) and Times to be Provided by PMT/Amtrak *****

NOTICE TO CONTRACTOR – PHOTO IDENTIFICATION

The Contractor is hereby notified that all employees, including subcontractors, who will work on the Project will be required to carry personal photo identification, such as a valid driver's license.

NOTICE TO CONTRACTOR – AMTRAK SPECIFICATIONS

The Contractor is hereby notified that the following Amtrak specifications and requirements are included in the CSI-formatted specification section and are applicable and are hereby made part of this contract. These procedures must be allowed by the contractor when working on Amtrak right of way.

Section	Rev. #	Date	Title
01141A	3	02/03/2006	Safety and Protection of Railroad Traffic and Property.
01142A	1	12/15/2005	Submission Documentation Required for Amtrak Review and Approval of Plans for Bridge Erection, Demolition and Other Crane/Hoisting Operations over Railroad Right-of-Way
01520A	1	08/07/2001	Requirements for Temporary Protection Shields for Demolition and Construction of Overhead Bridges and other Structures
02261A	3	06/20/2008	Requirements for Temporary Sheeting and Shoring to Support Amtrak Tracks

NOTICE TO CONTRACTOR – TRACK MONITORING

Scope: If any work that could potentially affect the stability of the track is occurring within 50 feet of a track, or within the influence line of a track, then monitoring points shall be established along the track. The influence line descends from a point one foot horizontally away from the outside end of the tie bottom one unit vertically for every unit and a half horizontally.

Safety: All work close enough to foul a track must only be performed under the direction of qualified railroad personnel. People performing track monitoring are classified as Roadway Workers and must be trained in Roadway Worker Protection.

Points: Each location shall include a point on the top of rail marked with paint or crayon on the field side of the rail and used for vertical measurements, and a point on the tie for horizontal measurements. In wood ties, the point shall be marked with a PK nail or similar surveyor's marker; on concrete or steel ties the point shall be marked with paint.

Point Locations: Reference points shall be established along the track beginning at the point where the work is closest to the track. Points shall continue to be placed at intervals of 50 feet along the track to the point where the work ends or does not meet the conditions outlined above, and then at 50 feet, 100 feet, and 200 feet away from the end point(s). Where more than one track may be affected, points shall be established on each track that could be affected.

Measurement Accuracy: Monitoring points shall be established to within 0.001 feet, and monitoring shall be done to 0.01 feet.

Monitoring: Monitoring shall be performed at the beginning and end of every shift of work. Points shall be measured, the measurements recorded, and the numbers compared with previous measurements. All points shall be measured each time monitoring occurs, except for the points 200 feet away from the end of work; these points shall only be measured if any of the other measurements exceeds an allowable deviation.

Allowable deviations: If track is found to have moved either vertically or horizontally by more than one half of the Amtrak Maintenance limits as specified in Amtrak's MW-1000 for the particular class of track involved, then all work shall cease immediately and the contractor shall immediately notify the designated Amtrak Project Engineer. Work may not resume until the designated Amtrak Project Engineer has inspected the site and approved.

Track Maintenance: Deficiencies in track surface and alignment caused by construction activities shall be corrected solely by Amtrak forces at project expense.

For measurement and payment for work described in this Notice to Contractor see ITEM No. 0000985A – Track Monitoring.

TRACK CLASS	MAX. PASSENGER SPEED (MPH)	CROSS LEVEL (INCHES) The Difference in Cross Level Between Any Two Points Less Than		DEVIATION FROM UNIFORM PROFILE (INCHES)		DEVIATION FROM HORIZONTAL ALIGNMENT (INCHES)	DEVIATION FROM HORIZONTAL ALIGNMENT (INCHES)
		10’	62’	31’ CHORD	62’ CHORD	31’ CHORD	62’ CHORD
MAINTENANCE LIMITS							
1	15	1	2 ¼	N/A	2 ¼	2 ¾	3 ¾
2	30	1	1 ⅝	N/A	2	1 ½	2 ¼
3	60	1	1 ½	N/A	1 ⅝	7/8	1 ¼
4	80	1	1 ¼	N/A	1 ½	¾	1
5	90	1	1 ⅛	N/A	1	⅜	½
6	110	¾	1	¾	¾	⅜	½
7	125	¾	1	¾	¾	⅜	⅜
8	160	¾	1	½	¾	⅜	⅜
9	200	¾	1	⅜	½	⅜	⅜
½ MAINTENANCE LIMITS							
1	15	½	1⅛	N/A	1 ⅛	1 ⅜	1 ⅞
2	30	½	13/16	N/A	1	¾	1 ⅛
3	60	½	¾	N/A	13/16	7/16	⅝
4	80	½	⅝	N/A	¾	⅜	½
5	90	½	9/16	N/A	½	3/16	¼
6	110	⅜	½	⅜	⅜	3/16	¼
7	125	⅜	½	⅜	⅜	3/16	3/16
8	160	⅜	½	¼	⅜	3/16	3/16
9	200	⅜	½	3/16	¼	3/16	3/16

NOTICE TO CONTRACTOR – TACTILE WARNING STRIP

The installation of the Tactile Warning Strip requires close coordination between the Contractor and the supplier/installer. This coordination is the sole responsibility of the Contractor and there will be no compensation for delays caused by the lack of coordination.

NOTICE TO CONTRACTOR – RAILROAD SAFETY TRAINING

All individuals employed by the Contractor and its subcontractors shall attend AMTRAK's Safety Contractor/Leasee Employee Training Class prior to entering onto the Railroad's property or coming within twenty-five (25) feet of the centerline of the track or energized wires. It is the Contractor's responsibility to arrange this Safety Training. All costs associated with this class shall be included in the Major Lump Sum Item for the project. The current rate schedule for this training is attached.

NOTICE TO CONTRACTOR – PEDESTRIAN BRIDGE STRUCTURES

The Contractor is hereby advised that he is responsible for obtaining all permits such as Oversized Load and Over Height, that may be required for delivery of the Berlin, Meriden and Wallingford pedestrian bridges, and for developing a delivery route, approved by the Department, to the Project site prior to fabrication of the pedestrian bridge. Refer to Form 816 Article 1.07.05 for additional information in this regard.

An erection plan for the pedestrian shall be submitted to the Engineer and to AMTRAK, and no work on the installation of the pedestrian bridge shall commence until the erection plan has been approved.

The Department has determined that, in order to minimize disruption to the railroad, all structural steel, the entire corrugated steel deck, the electrical conduits under the steel deck, and the majority of the metal roofing for the bridge (with the exception of identified or approved lifting points for installation) be in place prior to placing the bridge. Steel windows and other finishes can be installed after the bridge is erected, however AMTRAK will require all openings in the side of the bridge be temporarily covered following erection.

The Contractor is responsible for any damage to the pedestrian bridge, steel deck, and metal roof deck during transport and placing operations, and shall make all necessary repairs and or replacements to the Engineer's satisfaction.

The Contract includes additional information regarding this activity. The Contractor shall comply with all requirements of the NOTICE TO CONTRACTOR – WORK ON RAILROAD PROPERTY to install the pedestrian bridge during off-peak hours.

The Contractor shall bid the Project accordingly.

NOTICE TO CONTRACTOR - SIGN INVENTORY

Prior to the commencement of construction, the Contractor and the Engineer shall conduct a joint inventory of signs, delineators and object markers. Signs, delineators or object markers that are knocked down or destroyed by the Contractor during the construction of the project shall be replaced by the Contractor at no cost to the State.

NOTICE TO CONTRACTOR – SAFEGUARDING OF RESIDENCES AND COMMERCIAL PROPERTIES

The Contractor shall maintain and protect traffic operations at all driveways and provide adequate sightline. The Contractor shall not restrict sightline with construction equipment when not actively working. The Contractor shall also safeguard pedestrian operation and maintain access to properties at all times.

NOTICE TO CONTRACTOR – NOISE POLLUTION

The Contractor shall take measures to control the noise intensity caused by his construction operations and equipment, including but not limited to equipment used for drilling, pile driving, blasting, excavation or hauling.

All methods and devices employed to minimize noise shall be subject to the continuing approval of the Engineer. The maximum allowable level of noise at the nearest residence or occupied building shall be 90 decibels on the "A" weighted scale (dBA). Any operation that exceeds this standard will cease until a different construction methodology is developed to allow work to proceed within the 90 dBA limit.

NOTICE TO CONTRACTOR – MUNICIPAL DEMOLITION PERMIT

In accordance with CGS 29-401 through 29-415, the Contractor is hereby advised of the need to apply for and obtain a demolition permit from the municipality for each building to be demolished as part of this Project prior to initiating any demolition activities. Said statutes permit a waiting period from the demolition permit application of not more than 90 days. The Contractor shall schedule its work and bid the Project accordingly.

SECTION 1.05 – CONTROL OF THE WORK

1.05.02--Plans, Working Drawings, and Shop Drawings:

Delete the entire subsection entitled "3. Shop Drawings:"

1.05.06--Cooperation with Utilities (including Railroads):

Add the following after the last paragraph:

"Special Requirements Regarding Work in AMTRAK territory:

Description:

This section covers authority, definitions, regulatory requirements, traffic regulation and coordination of the Contractor's work schedule with the operation of train service, construction equipment and safety requirements for working within railroad right-of-way, and provisions for storage of materials and equipment and worker safety rules. Subsequent to the Engineer's Pre-Construction Meeting and prior to commencement to Contract activities, the Engineer will hold a Working on the Railroad Meeting to emphasis these Specifications."

SECTION 1.08 - PROSECUTION AND PROGRESS

Replace 1.08.01 – "Transfer of Work or Contract" with the following:

1.08.01—Transfer of Work or Contract: The Contractor shall perform with its own organization Contract work with a value under the Contract of at least 50% of the original total Contract value. If the Contractor sublets, sells, transfers, or otherwise disposes of any part of the Contract work without the Commissioner's prior written consent, the Contractor will not be relieved of any Contractual or other legal responsibility in connection therewith. Such an unauthorized act by the Contractor shall constitute a material breach of the Contract, and the Commissioner may, in such a case, terminate the Contract without further compensation to the Contractor.

The Contractor shall include the following alternative dispute resolution clause in all of its Project subcontracts:

"For any dispute arising out of the agreement between the Contractor and a subcontractor, including claims of late payment or non-payment, which cannot be settled within 60 days of the subcontractor submitting a written claim to the Contractor, either party may bring the dispute before an alternative dispute resolution entity for resolution. If the parties do not agree upon a particular dispute resolution entity for that purpose, the dispute shall be resolved under the auspices and construction arbitration rules of the American Arbitration Association, or under the rules of any other alternative dispute resolution entity approved by the Department either generally or for the specific dispute. The Department may not be made a party to formal arbitration regarding such a dispute. These rights and restrictions may not be waived, and if these provisions are not included in the Contractor's subcontracts for the Project, these provisions shall nonetheless be read into them."

The Contractor shall not knowingly enter into any lower tier transaction on a Department project with any person or entity which, under any federal or state law or regulation, or by voluntary agreement, is currently debarred or disqualified from bidding for construction contracts or participating in construction projects in any jurisdiction within the United States, unless after disclosure of such ineligibility, such participation is authorized by appropriate federal and State authorities, including the Commissioner.

The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the Contract or any portion thereof, or of the work provided for therein, or of its right, title, or interest therein, to any individual or entity without the prior written consent of the Commissioner. No payment will be made for any part of the work sublet, sold, transferred, assigned, or otherwise disposed of by the Contractor, prior to the authorization date given in the written consent of the Commissioner. Such an unauthorized act by the Contractor shall constitute a material breach of the Contract, and the Commissioner may, in such a case, terminate the Contract without further compensation to the Contractor.

The Contractor shall pay the subcontractor for work performed within thirty (30) days after the Contractor receives payment for the work performed by the subcontractor. Withholding retainage by the Contractor, subcontractor or lower tier subcontractors is not allowed.

Payment for work that has been performed by a subcontractor does not eliminate the Contractor's responsibilities for all the work as defined in Article 1.07.12, "Contractor's Responsibility for Work."

Payment for work that has been performed by a subcontractor also does not release the subcontractor from its responsibility for maintenance and other periods of subcontractor responsibility specified for the subcontractor's items of work. Failure of a subcontractor to meet its maintenance, warranty and/or defective work responsibilities may result in administrative action on future Department contracts.

For any dispute regarding prompt payment, the alternate dispute resolution provisions of this article shall apply.

The above requirements are also applicable to all sub-tier subcontractors and the above provisions shall be made a part of all subcontract agreements.

Failure of the Contractor to comply with the provisions of this section may result in a finding that the Contractor is non-responsible on future projects.

Article 1.08.07 - Determination of Contract Time:

Delete the second, third and fourth paragraphs and replace them with the following:

When the contract time is on a calendar day basis, it shall be the number of consecutive calendar days stated in the contract, INCLUDING the time period from December 1 through March 31 of each year. The contract time will begin on the effective date of the Engineer's order to commence work, and it will be computed on a consecutive day basis, including all Saturdays, Sundays, Holidays, and non-work days.

1.08.08 - Extension of Time:

Delete the last paragraph, "If an approved extension of time…. the following April 1".

Article 1.08.09 - Failure to Complete Work on Time:

Delete the second paragraph, "If the last day...the project is substantially completed" *and replace it with* "Liquidated damages as specified in the Contract shall be assessed against the Contractor per calendar day from that day until the date on which the project is substantially completed.".

ITEM #0000985A – TRACK MONITORING

Description: The Contractor shall monitor track horizontal and vertical movement in allowance with this special provision as follows:

Survey work shall be performed by a Registered Land Surveyor in the State of Connecticut. Survey crew should be trained under AMTRAK's Railroad's Safety Contractor/Leasee Employee Training program and maintain certification for the duration of the work.

Railroad traffic shall be maintained at all times with safety and continuity, and Contractors shall conduct their operations in compliance with all rules, regulations, and requirements of Railroad (including these Specifications) with respect to any work performed on, over, under, within or adjacent to Railroad's property. Contractors shall be responsible for acquainting themselves with such rules, regulations and requirements. Any violation of Railroads safety rules, regulations, or requirements shall be grounds for the immediate suspension of the Contractor work, and the re-training of all personnel, at the Contractor's expense.

Scope: If any work that could potentially affect the stability of the track is occurring within 50 feet of a track, or within the influence line of a track, then monitoring points shall be established along the track. The influence line descends from a point one foot horizontally away from the outside end of the tie bottom one unit vertically for every unit and a half horizontally.

Safety: All work close enough to foul a track must only be performed under the direction of qualified railroad personnel. People performing track monitoring are classified as Roadway Workers and must be trained in Roadway Worker Protection.

Points: Each location shall include a point on the top of rail marked with paint or crayon on the field side of the rail and used for vertical measurements, and a point on the tie for horizontal measurements. In wood ties, the point shall be marked with a PK nail or similar surveyor's marker; on concrete or steel ties the point shall be marked with paint.

Point Locations: Reference points shall be established along the track beginning at the point where the work is closest to the track. Points shall continue to be placed at intervals of 50 feet along the track to the point where the work ends or does not meet the conditions outlined above, and then at 50 feet, 100 feet, and 200 feet away from the end point(s). Where more than one track may be affected, points shall be established on each track that could be affected.

Measurement Accuracy: Monitoring points shall be established to within 0.001 feet, and monitoring shall be done to 0.01 feet.

Monitoring: Monitoring shall be performed at the beginning and end of every shift of work. Points shall be measured, the measurements recorded, and the numbers compared with previous measurements. All points shall be measured each time monitoring occurs, except for the points

200 feet away from the end of work; these points shall only be measured if any of the other measurements exceeds an allowable deviation.

Allowable deviations: If track is found to have moved either vertically or horizontally by more than one half of the Amtrak Maintenance limits as specified in Amtrak's MW-1000 for the particular class of track involved, then all work shall cease immediately and the contractor shall immediately notify the designated Amtrak Project Engineer. Work may not resume until the designated Amtrak Project Engineer has inspected the site and approved.

Track Maintenance: Deficiencies in track surface and alignment caused by construction activities shall be corrected solely by Amtrak forces at project expense.

TRACK CLASS	MAX. PASSENGER SPEED (MPH)	CROSS LEVEL (INCHES) The Difference in Cross Level Between Any Two Points Less Than		DEVIATION FROM UNIFORM PROFILE (INCHES)		DEVIATION FROM HORIZONTAL ALIGNMENT (INCHES)	DEVIATION FROM HORIZONTAL ALIGNMENT (INCHES)
		10'	62'	31' CHORD	62' CHORD	31' CHORD	62' CHORD
MAINTENANCE LIMITS							
1	15	1	2 ¼	N/A	2 ¼	2 ¾	3 ¾
2	30	1	1 ⅝	N/A	2	1 ½	2 ¼
3	60	1	1 ½	N/A	1 ⅝	7/8	1 ¼
4	80	1	1 ¼	N/A	1 ½	¾	1
5	90	1	1 ⅛	N/A	1	⅜	½
6	110	¾	1	¾	¾	⅜	½
7	125	¾	1	¾	¾	⅜	⅜
8	160	¾	1	½	¾	⅜	⅜
9	200	¾	1	⅜	½	⅜	⅜
½ MAINTENANCE LIMITS							
1	15	½	1⅛	N/A	1 ⅛	1 ⅜	1 ⅞
2	30	½	13/16	N/A	1	¾	1 ⅛
3	60	½	¾	N/A	13/16	7/16	⅝
4	80	½	⅝	N/A	¾	⅜	½
5	90	½	9/16	N/A	½	3/16	¼
6	110	⅜	½	⅜	⅜	3/16	¼
7	125	⅜	½	⅜	⅜	3/16	3/16
8	160	⅜	½	¼	⅜	3/16	3/16
9	200	⅜	½	3/16	¼	3/16	3/16

Materials: As determined by the Contractor and approved by the Engineer and Amtrak.

Construction Methods: The Contractor shall submit a detailed method of track monitoring to the Engineer and Amtrak for review and approval prior to performing any sheet pile driving within 50 feet of the track and/or any excavation or directional drilling operations under the tracks.

Method of Measurement: This work will be paid for on a lump sum basis and will not be measured for payment.

Basis of Payment: This work will be paid for at the contract lump sum price for "Track Monitoring", which price shall include all materials, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
Track Monitoring	l.s.

ITEM #0063___A – REVENUE COLLECTION SYSTEM (SITE NO. 1)

ITEM #0063___A – REVENUE COLLECTION SYSTEM (SITE NO. 3)

ITEM #0063___A – REVENUE COLLECTION SYSTEM (SITE NO. 4)

Description: Work under this item shall consist of the furnishing of a complete revenue collection system (RCS), for the site specified, as shown on plans and in accordance with these specifications. This shall include the pay-by-space (PBS) meters and associated parts, as well as any proprietary system software. The installation of the RCS is not included under this item.

Furnishing and installing items incidental to the RCS are not included under this item. These items include, but are not limited to, conduit, wiring, splice boxes, RCS signage, sign posts, pavement markings for stall numbering, "back office" hardware, concrete, reinforcing steel, crushed stone, excavation, backfill, bollards and handholes.

Installation of the RCS, as well as furnishing and installing items incidental to the RCS, shall be in accordance with the following special provisions:

Form 816, Item No. 0063521 – Rail Facility Upgrade (Site No. 1)
Form 816, Item No. 0063523 – Rail Facility Upgrade (Site No. 3)
Form 816, Item No. 0063524 – Rail Facility Upgrade (Site No. 4)
CSI, Section No. 116000 – Revenue Collection System

Materials: The revenue collection system (RCS) shall be the LUKE II, as manufactured by Digital Payment Technologies, 330-4260 Still Creek Drive, Burnaby, BC, V5C 6C6, Canada, 888-687-6822. **This is a sole source item and no substitutions will be allowed.**

Manufacturer's catalog cuts, listing detailed specifications of the RCS, shall be submitted in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

Spare Parts, Warranty, and Operation and Maintenance Manuals shall be submitted in accordance with Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

Spare parts shall include: one (1) pay-by-space (PBS) meter, one (1) battery per each PBS meter, and assorted spare parts in accordance with the manufacturer's documented recommendations for routine maintenance and repair.

Construction Methods: Delivery, storage and handling shall be in accordance with Form 816, Articles 1.06.03 and 1.20-1.06.03.

All spare parts shall be packaged in protective covering for storage and clearly identified with labels describing contents

Method of Measurement: This work will be paid for on a lump sum basis and will not be measured for payment.

Basis of Payment: This work will be paid for at the contract lump sum price for "REVENUE COLLECTION SYSTEM (SITE NO. X)", which price shall include the furnishing of a complete revenue collection system for each site, in accordance with the Contract Documents.

PAY ITEM	PAY UNIT
Revenue Collection System (Site No. X)	LS

ITEM #0063521A – RAIL FACILITY UPGRADE SITE NO. 1

ITEM #0063522A – RAIL FACILITY UPGRADE SITE NO. 2

ITEM #0063523A – RAIL FACILITY UPGRADE SITE NO. 3

ITEM #0063524A – RAIL FACILITY UPGRADE SITE NO. 4

Description: Under this item, the Contractor shall complete all work depicted on the Contract Plans and described in the CSI-formatted Specifications that make up this Major Lump Sum Item (MLSI). Refer to Form 816 Article 1.20-1.02.04 for additional information in this regard.

Any work incidental to another bid item which is not specifically described or included in the bid item, but which is required for performance and completion of the work required under the Contract, shall be considered to be included under this item.

Materials: All materials shall be as required by the Contract Plans and as described in the CSI-formatted Specifications that make up this MLSI.

Construction Methods: All methods of construction shall conform to the requirements as stipulated in the CSI-formatted Specifications that make up this MLSI.

Method of Measurement: This item will be paid for at the contract lump sum price for "RAIL FACILITY UPGRADE SITE NO. X" complete.

Basis of Payment: This item will be paid for at the contract lump sum price for "RAIL FACILITY UPGRADE SITE NO. X", which price shall include all administrative and procedural requirements, material, equipment, labor, and work incidental thereto.

Pay Item	Pay Unit
Rail Facility Upgrade Site No. X	LS

ITEM #0100500A - CONSTRUCTION COMMUNICATION EQUIPMENT

Description:

Under this item, the Contractor shall provide:

1. Communication equipment for use by the inspection personnel. This item shall include all necessary equipment, accessories, material and labor to put the system into operation. Provisions shall also be made to maintain all provided communication equipment and any additional communication equipment assigned to the project, as directed by the Engineer.
2. A toll-free, reservation-less telephone conference call account for the use of the Engineer.

Materials:

The equipment for this item shall conform to the following: A hand held cellular phone capable of communicating digitally between units with two-way radio feature. This item shall include all necessary equipment, accessories (including but not limited to car charger and holster), materials, labor and maintenance to make the system operational. In addition, the phones shall have voice mail, caller ID and call waiting.

Construction Methods:

1. Communication Equipment: The Contractor shall submit three (3) proposals for both the communication equipment described herein and forward to the Engineer for approval. The Department will provide the Contractor with the estimated quantity of phones required for inspection personnel.

   The three proposals may be for either rental or purchase of equipment that is new or of like-new condition and meeting the specification requirements. Also, the three proposals must indicate the minimum and maximum number of phones that will be allotted. The Engineer will have ten (10) days from receipt of the proposals to inform the Contractor of its selection. Once approved, the contractor shall order the equipment, and have it installed and operating within fifteen (15) working days.

   The Contractor will furnish to the State, a copy of the monthly call record for each phone when submitting the billing invoices for the communication equipment.

   All equipment and associated materials will remain the property of the Contractor upon completion of the project unless otherwise specified by the Engineer in writing.

2. Telephone Conference Call Account: The Contractor shall submit three (3) proposals for the telephone conference call account described herein and forward to the Engineer for approval.

   The Engineer will have ten (10) days from receipt of the proposals to inform the Contractor of its selection. Once approved, the contractor shall activate the account within five (5) working days.

   Once activated, the Engineer will act as the "moderator" and control all associated PIN numbers.

   The Contractor will furnish to the State, a copy of the detailed monthly account history when submitting the billing invoices for the telephone conference call account.

Method of Measurement: The item, Construction Communication Equipment, will be measured for payment based on actual detailed monthly invoices.

Basis of Payment: The sum of money shown on the Estimate and in the itemized proposal as "Estimated Cost" for this work will be considered the bid price even though payment will be made as described below. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figures will be disregarded and the original price will be used to determine the total amount for the contract.

The item, "Construction Communication Equipment", will be paid for at the actual detailed monthly account history for services approved by the Engineer, plus a 5% markup.

Payment will include all materials, equipment, labor and maintenance associated with this item.

Pay Item	Pay Unit
Construction Communication Equipment	EST.

ITEM #0201001A – CLEARING AND GRUBBING

Article 2.01 Clearing and Grubbing, shall be supplemented as follows:

Article 2.01.01 - Description: Add the following:

This item shall include the removal and disposal of granite stone curbing as shown on the plans or as ordered by the Engineer.

Article 2.01.05 - Basis of Payment: Add the following:

All costs incidental to the removal and disposal of granite stone curbing will be included in the price of "Clearing and Grubbing."

ITEM #0210100A – ANTI-TRACKING PAD

Description: Work under this item shall consist of the installation, maintenance, and removal of an anti-tracking pad for the Contractor Staging Area, of the dimensions specified and at the locations shown on the Plan or as ordered by the Engineer.

Materials: The crushed stone for this work shall conform to the requirements of Article M.01.01 for No. 3 coarse aggregate. Geotextile shall conform to the requirements of Article M.08.01-26. Materials incidental to and necessary for the installation of the geotextile, such as, but not limited to sewing thread, staples, pins, etc. shall conform to the requirements of the manufacturer of the geotextile.

Construction Methods: The area on which the anti-tracking pad is to be placed shall be shaped to a reasonable true surface prior to the installation of the geotextile. The geotextile shall be installed at the location and to the dimensions shown on the plans or as directed by the Engineer. Geotextile shall be installed as recommended by the manufacturer for the specific use or purpose intended, or as otherwise approved by the Engineer. The crushed stone shall be spread by any suitable means that will not crush the stone and shall be shaped to a smooth uniform finished grade.

Upon completion of the project, the anti-tracking pad shall be removed and the site restored.

Method of Measurement: This work will be measured by the actual number of square yards of completed and accepted anti-tracking pad. The geotextile will not be measured for payment but shall be considered incidental to the work.

Basis of Payment: This work will be paid for at the contract unit price per square yard for "Anti-Tracking Pad" which price shall include all excavation, backfill, disposal of surplus material, crushed stone, geotextile, and all equipment, tools, labor and materials incidental to installing, maintaining and removing the anti-tracking pad.

Pay Item	Pay Unit
Anti-Tracking Pad	s.y.

ITEM NO. 0219011A – SEDIMENT CONTROL SYSTEM AT CATCH BASIN

Work under this item shall conform to the applicable provisions of Section 2.19 of the Standard Specifications Form 816 amended as follows:

Description: This work shall consist of furnishing, placing, maintaining and removing sedimentation control systems at catch basins as shown on the plans and as directed by the Engineer. Maintaining shall include the cleanout and proper disposal of accumulated sediment.

Materials: Geotextile for this work shall conform to Section 7.55 and M.08.

Construction Methods: Sediment Control System at Catch Basin shall be installed by the Contractor at locations shown on the plans or as directed by the Engineer in accordance with the applicable sections of Section 2.19 of the Standard Specifications and the details in the plans.

Method of Measurement: This work will be measured for payment by the actual number of catch basins installed and accepted with a Sediment Control System at Catch Basin installation.

Basis of Payment: This work will be paid for at the contract unit price each for "Sediment Control System at Catch Basin" complete in place, which price shall include all materials, equipment, tools, and labor incidental to the installation, maintenance, replacement, removal and disposal of the system an surplus material. No payment shall be made for the cleanout of accumulated sediment.

Pay Item	Pay Unit
Sediment Control System at Catch Basin	ea

ITEM #0406177A – POROUS PAVEMENT – HMA

Description:

This item consists of furnishing porous pavement at the locations and to the limits indicated on the Drawings or as ordered by the Engineer. Perform the work in accordance with Form 816, Section 4.06 and the following.

Materials:

Material shall be accordance with the following:

Form 816, Section 4.06
Performance Graded Binder, PG 70-22, or PG 76-22

Aggregate Gradation: See Drawings.

Porous Asphalt Mix

1. Mix materials

Mix materials consist of modified performance grade asphalt binder (PGAB), coarse and fine aggregates, and optional additives such as silicone, fibers, mineral fillers, fatty amines, and hydrated lime. Materials shall meet the requirements of the NAPA's Design, Construction, and Maintenance of Open-Graded Friction Courses, Information Series 115 (2002), except where noted otherwise below or approved in writing by the Engineer.

2. Polymer Modified PGAB and Mix Designs.

The asphalt binder shall be a polymer and/or fiber modified Performance Graded asphalt binder (PGAB) used in the production of Superpave Hot Mix Asphalt (HMA) mixtures. Ideally for maximum durability, the PGAB shall be two grades stiffer than that required for dense mix asphalt (DMA) parking lot installations, which is often achieved by adding a polymer and/or fiber. Mix designs will meet or exceed criteria listed in Table 1.

The PGAB polymer modifiers are to be either styrene butadiene rubber (SBR) or styrene butadiene styrene (SBS). The quantity of rubber solids in the SBR shall typically be 1.5-3% by weight of the bitumen content of the mix.

The dosage of fiber additives shall be either 0.3 percent cellulose fibers or 0.4 percent mineral fibers by total mixture mass. Fibers are a simple addition either manually for a batch plant or automated for larger drum plants. The binder shall meet the requirements of AASHTO M320.

The PGAB may be pre-blended or post-blended. The pre-blended binder can be pre-blended at the source or at a terminal. For post-blended addition, the modifier can either be in-line blended or injected into the pugmill at the plant.

3. Anti-Stripping Mix Additives.

The mix shall be tested for moisture susceptibility and asphalt stripping from the aggregate by AASHTO T283. If the retained tensile strength (TSR) < 80% upon testing, a heat stable additive shall be furnished to improve the anti-stripping properties of the asphalt binder. Test with one freeze-thaw cycle (rather than five recommended in NAPA IS 115). The amount and type of additive (e.g. fatty amines or hydrated lime) to be used shall be based on the manufacturer's recommendations, the mix design test results, and shall be approved by the Engineer.

Silicone shall be added to the binder at the rate of 1.5 mL/m3 (1 oz. per 5000 gal).

Fibers may be added per manufacturer and NAPA IS 115 recommendation if the draindown requirement cannot be met (<0.3% via ASTM D6390) provided that the air void content requirement is met (>18%, or >16% as tested with CoreLok device).

Additives should be added per the relevant DOT specification and NAPA IS 115.

4. Coarse Aggregate.

Coarse aggregate shall be that part of the aggregate retained on the No. 8 sieve; it shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel of uniform quality throughout. Coarse aggregate shall be crushed stone or crushed gravel and shall have a percentage of wear as determined by AASHTO T96 of not more than 40 percent. In the mixture, at least 75 percent, by mass (weight), of the material coarser than the 4.75 mm (No. 4) sieve shall have at least two fractured faces, and 90 percent shall have one or more fractured faces (ASTM D5821). Coarse aggregate shall be free from clay balls, organic matter, deleterious substances, and a not more than 8.0% of flat or elongated pieces (>3:1) as specified in ASTM D4791.

5. Fine Aggregate.

The fine aggregate shall be that part of the aggregate mixture passing the No. 8 sieve and shall consist of sand, screenings, or combination thereof with uniform quality throughout. Fine aggregate shall consist of durable particles, free from injurious foreign matter. Screenings shall be of the same or similar materials as specified for coarse aggregate. The plasticity index of that part of the fine aggregate passing the No. 40 sieve shall be not more than 6 when tested in accordance with AASHTO T90. Fine aggregate from the total mixture shall meet plasticity requirements.

6. Porous Asphalt Mix Design Criteria.

The Contractor shall submit a mix design at least 10 working days prior to the beginning of production. The Contractor shall make available samples of coarse aggregate, fine aggregate, mineral filler, fibers and a sample of the PGAB that will be used in the design of the mixture. A certificate of analysis (COA) of the PGAB will be submitted with the mix design. The COA will be certified by a laboratory meeting the requirements of AASHTO R18. The Laboratory will be certified by the state DOT, regional equivalent (e.g. NETTCP), and/or qualified under ASTM D3666. Technicians will be certified by the regional certification agency (e.g. NETTCP) in the discipline of HMA Plant Technician.

Bulk specific gravity (SG) used in air void content calculations shall not be determined and results will not be accepted using AASHTO T166 (saturated surface dry), since it is not intended for open graded specimens (>10% AV). Bulk SG shall be calculated using AASHTO T275 (paraffin wax) or ASTM D6752 (automatic vacuum sealing, e.g. CoreLok). Air void content shall be calculated from the bulk SG and maximum theoretical SG (AASHTO T209) using ASTM D3203.

The materials shall be combined and graded to meet the composition limits by mass (weight) as shown on the Drawings and the following.

Table 1

Binder Content (AASHTO T164):	6 - 6.5%
Fiber Content by Total Mixture Mass	0.3% cellulose or 0.4% mineral
Rubber Solids (SBR) Content by Weight of the Bitumen	1.5-3% or TBD
Air Void Content (ASTM D6752/AASHTO T275)	16.0-22.0%
Draindown (ASTM D6390)*	< 0.3 %
Retained Tensile Strength (AASHTO 283)**	> 80 %
Cantabro abrasion test on unaged samples (ASTM D7064_04)	< 20%
Cantabro abrasion test on 7 day aged samples	< 30%

Porous Asphalt Mix Production

1. Mixing Plants.

Mixing plants shall meet the requirements of hot mix asphalt plants as specified in Form 816 or latest revised edition and including supplemental specifications and updates.

2. Preparation of Asphalt Binder.

The asphalt material shall be heated to the temperature specified in the state DOT specification (if using a DOT spec for the mix) in a manner that will avoid local overheating. A continuous supply of asphalt material shall be furnished to the mixer at a uniform temperature.

3. Preparation of Aggregates.

The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damaging the aggregate and depositing soot or unburned fuel on the aggregate.

4. Mineral filler

Mineral filler if required to meet the grading requirements, shall be added after the aggregates have passed through the dryer.

5. Mixing.

The above preparation of aggregates does not apply for drum-mix plants. The dried aggregate shall be combined in the mixer in the amount of each fraction of aggregate required to meet the job-mix formula and thoroughly mixed prior to adding the asphalt material. The dried aggregates shall be combined with the asphalt material in such a manner as to produce a mixture that when discharged from the pugmill is at a target temperature in the range that corresponds to an asphalt binder viscosity of 700 to 900 centistokes and within a tolerance of ± 11 °C (± 20 °F).

The asphalt material shall be measured or gauged and introduced into the mixer.

After the required quantity of aggregate and asphalt material has been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the asphalt material throughout the aggregate is secured.

All plants shall have a positive means of eliminating oversized and foreign material from being incorporated into the mixer.

Construction Methods:

General

Equipment for porous HMA pavement operations shall be in accordance with Form 816, Section 4.06.

Fuel oil, kerosene, or other solvents shall not be transported in open containers on any equipment at any time. Cleaning of equipment and tools shall not be accomplished on the pavement or paved shoulder areas.

Mix the aggregate and asphalt binder material within the established temperature range until all the materials are coated.

Segregation, flushing or bleeding of porous HMA pavement mixtures will not be permitted. Corrective action shall be taken to prevent the continuation of these conditions. All areas showing an obvious excess or deficiency of asphalt materials shall be removed and replaced. All mixture that becomes loose and broken, mixed with dirt, or is in any way obviously defective shall be removed and replaced.

Preparation of Surfaces

Surfaces on which a porous HMA pavement mixture is to be placed shall be open graded free draining aggregate and free from objectionable or foreign materials at the time of placement. Contact surfaces of curbing, gutters, manholes, and other structures shall be tack coated. Protect the mixture at all times from contamination by soil or other fine material during placement.

Weather Limitations

Do not place the mixture during weather conditions that would cause its degradation, segregation, or contamination.

Spreading and Finishing

The porous HMA pavement will be placed in a single lift of a maximum of 4 inches. The mixture shall be placed upon an approved surface by means of a suitable asphalt paver. If hand work is required it shall be kept to a minimum. Spread the mixture in a method that produces a smooth, uniform layer before compacting. Do not haul over the mixture.

Joints

Longitudinal joints on roads and streets shall be offset from lane lines a distance of 6 inches whenever possible. Transverse joints shall be constructed by exposing a near vertical full depth face of the previous course.

Compaction

The porous HMA pavement mixture shall be compacted with equipment in accordance with Form 816, Section 4.06, immediately after the mixture has been spread and finished. Rollers shall not cause undue displacement, cracking, or shoving.

Compact the mixture using a minimum of two (2) passes with a 10 ton static tandem steel wheel roller (do not use the roller in a vibratory mode), completely seating the aggregate particles. Do not over compact resulting in crushed or broken aggregate. Complete rolling before mix temperatures drop below 250 degrees F.

Traffic should be restricted for 24 hours after rolling.

Pavement Smoothness and Acceptance

Thickness Tolerance: Ensure the placed porous HMA pavement conforms to the specified thickness by randomly checking the thickness during construction.

Surface Tolerance: Ensure that the finished surface is uniform and varies no more than plus or minus 1/2 inch from a 10-foot straight edge applied longitudinally to the asphalt mat.

Porosity Test will be performed by conducting a water hose test with five gallons per minute minimum. There should be immediate infiltration with no puddles.

Method of Measurement:

This work will be measured for payment by the number of ton of "Porous Pavement - HMA", furnished and installed.

Basis of Payment:

This work will be paid for at the contract unit price per ton for "Porous Pavement - HMA" complete in place, including all materials, off-site disposal, equipment, tools, labor and work incidental thereto.

No payment will be made for any work related to the replacement or correction of defective pavement.

Pay Item	Pay Unit
Porous Pavement-HMA	ton

ITEM #0406267A - MILLING OF HOT MIX ASPHALT (HMA) – (0-4 INCHES)
ITEM #0406268A - MILLING OF HOT MIX ASPHALT (HMA) – (OVER 4 TO 8 INCHES)
ITEM #0406269A - MILLING OF HOT MIX ASPHALT (HMA) – (GREATER THAN 8 INCHES)

Description: This work shall consist of the milling, removal, and disposal of existing HMA pavement.

Materials: The existing HMA surface shall be disposed of offsite by the Contractor at an approved disposal facility unless otherwise stated in the contract documents.

Construction Methods: The Contractor shall remove the HMA material using means acceptable to the Engineer. The pavement surface shall be removed to the line, grade, and existing or typical cross-section shown on the plans or directed by the Engineer.

The equipment for milling the pavement surface shall be designed and built for milling flexible pavements. It shall be self propelled with sufficient power, traction, and stability to maintain depth and slope and shall be capable of removing the existing HMA pavement.

The milling machine shall be equipped with a built-in automatic grade averaging control system that can control the longitudinal profile and the transverse cross-slope to produce the specified results. The longitudinal controls shall be capable of operating from any longitudinal grade reference, including string line, contact ski (30 feet minimum), non-contact ski (20 feet minimum), or mobile string line (30 feet minimum). The transverse controls shall have an automatic system for controlling cross-slope at a given rate. The Engineer may waive the requirement for automatic grade or slope controls where the situation warrants such action.

The rotary drum of the machine shall utilize carbide tip tools spaced not more than ⅝ inches apart. The forward speed of the milling machine shall be limited to no more than 45 feet/minute. The tools on the revolving cutting drum must be continually maintained and shall be replaced as warranted to provide a uniform pavement texture. The Contractor may request to perform a test strip to demonstrate that the same surface tolerance can be attained at an increased forward speed. The test strip shall be a maximum length of 500 feet and shall have the same criteria for surface tolerance as noted in this specification. The final decision for implementing the increased forward speed will be at the discretion of the Engineer.

The machine shall be equipped with an integral pickup and conveying device to immediately remove material being milled from the surface of the roadway and discharge the millings into a truck, all in one operation. The machine shall also be equipped with a

means of effectively limiting the amount of dust escaping from the milling and removal operation.

When milling smaller areas or areas where it is impractical to use the above described equipment, the use of a lesser equipped milling machine may be permitted when approved by the Engineer.

Protection shall be provided around existing catch basin inlets, manholes, utility valve boxes, and any similar structures. Any damage to such structures as a result of the milling operation is the Contractor's responsibility and shall be repaired at the Contractor's expense.

To prevent the infiltration of milled material into the storm drainage system, the Contractor shall take special care to prevent the milled material from falling into the inlet openings or inlet grates. Any milled material that has fallen into inlet openings or inlet grates shall be removed at the Contractor's expense.

Surface Tolerance: The milled surface shall provide a satisfactory riding surface with a uniform textured appearance. The milled surface shall be free from gouges, longitudinal grooves and ridges, oil film, and other imperfections that are a result of defective equipment, improper use of equipment, or poor workmanship. The Contractor, under the direction of the inspector, shall perform random spot-checks with a Contractor supplied ten-foot straightedge to verify surface tolerances at a minimum of five locations per day. The variation of the top of two ridges from the testing edge of the straightedge, between any two ridge contact points, shall not exceed ⅜ inch. The variation of the top of any ridge to the bottom of the groove adjacent to that ridge shall not exceed ⅜ inch. Any unsatisfactory surfaces produced are the responsibility of the Contractor and shall be corrected at the Contractor's expense and to the satisfaction of the Engineer.

The depth of removal will be verified by taking a measurement every 250 feet per each pass of the milling machine, or as directed by the Engineer. These depth measurements shall be used to monitor the average depth of removal.

Where a surface delamination between HMA layers or a surface delamination of HMA on Portland cement concrete causes a non-uniform texture to occur, the depth of milling shall be adjusted in small increments to a maximum of a +/- ½ inch to eliminate the condition.

When removing a HMA pavement entirely from an underlying Portland cement concrete pavement, all of the HMA pavement shall be removed leaving a uniform surface of Portland cement concrete, unless otherwise directed by the Engineer.

Any unsatisfactory surfaces produced by the milling operation are the Contractor's responsibility and shall be corrected at the Contractor's expense and to the satisfaction of the Engineer.

No vertical faces, transverse or longitudinal, shall be left exposed to traffic unless it meets the requirements below. This shall include roadway structures (catch basins, manholes, utility valve boxes, etc.). If any vertical face is formed in an area exposed to traffic a temporary paved transition will be established according to the requirements shown on the plans. If the milling machine is used to form a temporary transition, the length of the temporary transition shall conform to Special Provision Section 4.06 - Bituminous Concrete, "Transitions for Roadway Surface", the requirements shown on the plans, or as directed by the Engineer. At all permanent limits of removal, a clean vertical face shall be established by saw cutting prior to paving.

Roadway structures shall not have a vertical face of greater than 1 inch exposed to traffic as a result of milling. All structures within the roadway that are exposed to traffic and greater than 1 inch above the milled surface shall receive a transition meeting the following requirements:
For roadways with a posted speed limit of 35 mph or less*:

1. Round structures with a vertical face of greater than 1 inch to 2.5 inches shall be transitioned with a hard rubber tapered protection ring of the appropriate inside diameter designed specifically to protect roadway structures.
2. Round structures with a vertical face greater than 2.5 inches shall receive a transition of bituminous concrete formed at a minimum 24 to 1 taper.
3. All rectangular structures shall receive a transition of bituminous concrete formed at a minimum 24 to 1 taper.

*Bituminous concrete tapers at a minimum 24 to 1 taper may be substituted for the protection rings if approved by the Engineer.

For roadways with a posted speed limit of greater than 35 mph:

1. All structures shall receive a transition of bituminous concrete meeting the temporary transition requirements in Special Provision Section 4.06- Bituminous Concrete, "Transitions for Roadway Surface".

The milling operation shall proceed in accordance with the requirements of the "Maintenance and Protection of Traffic" and "Prosecution and Progress" specifications, or other contract requirements. The more stringent specification shall apply.

Prior to opening an area which has been milled to traffic, the pavement shall be thoroughly swept with a sweeper. The sweeper shall be equipped with a water tank and be capable of removing the millings and loose debris from the surface. Other sweeping equipment may be provided in lieu of the sweeper where acceptable by the Engineer.

Any milled area that will not be exposed to live traffic for a minimum of 48 hours prior to paving shall require a vacuum sweeper truck in addition to, or in lieu of, mechanical sweeping. The vacuum sweeper truck shall have sufficient power and capacity to completely remove all millings from the roadway surface including any fine particles within the texture of the milled surface. Vacuum sweeper truck hose attachments shall be

used to clean around pavement structures or areas that cannot be reached effectively by the main vacuum. Compressed air may be used in lieu of vacuum attachments if approved by the Engineer.

Method of Measurement: This work will be measured for payment by the number of square yards of area from which the milling of asphalt has been completed and the work accepted. No area deductions will be made for minor unmilled areas such as catch basin inlets, manholes, utility boxes and any similar structures.

The depth of removal will be calculated by taking a measurement at a minimum every 250 feet per each pass of the milling machine, or as directed by the Engineer. The average depth of each section will determine which payment item is applicable.

Basis of Payment: This work will be paid for at the contract unit price per square yard for "Milling of HMA (0 to 4 inches) (greater than 4 to 8 inches) (greater than 8 inches)". This price shall include all equipment, tools, labor, and materials incidental thereto.

No additional payments will be made for multiple passes with the milling machine to remove the bituminous surface.

No separate payments will be made for cleaning the pavement prior to paving; providing protection and doing handwork removal of bituminous concrete around catch basin inlets, manholes, utility valve boxes and any similar structures; repairing surface defects as a result of the Contractors negligence; providing protection to underground utilities from the vibration of the milling operation; removal of any temporary milled transition; removal and disposal of millings; furnishing a sweeper and sweeping after milling. The costs for these items shall be included in the contract unit price.

Pay Item	Pay Unit
Milling of Hot Mix Asphalt (HMA) – (0- 4 inches)	Sq. Yd
Milling of Hot Mix Asphalt (HMA) – (greater than 4 to 8 inches)	Sq. Yd
Milling of Hot Mix Asphalt (HMA) – (greater than 8 inches)	Sq. Yd

ITEM #0507171A -HYDRODYNAMIC SEPARATOR (SITE NO. 1)

ITEM #0507172A -HYDRODYNAMIC SEPARATOR (SITE NO. 2)

ITEM #0507173A -HYDRODYNAMIC SEPARATOR (SITE NO. 3)

ITEM #0507174A -HYDRODYNAMIC SEPARATOR (SITE NO. 4)

ITEM #0507175A -HYDRODYNAMIC SEPARATOR (SITE NO. 5)

Description: Hydrodynamic separators are proprietary devices manufactured for stormwater treatment. The hydrodynamic separator shall be a precast concrete structure and include an internal chamber with features that induce a swirling, circular, or spiraling flow pattern in the stormwater flow that separate and trap sediment and pollutants in a chamber that can be accessed for later removal.

This item will consist of furnishing and construction of a hydrodynamic separator, a flow diversion structure, manholes and pipes in the location, grades, treatment capacity and to the dimensions and details shown on the contract drawings, and in accordance with these specifications or as directed by the Engineer. The work also includes the preparation of hydraulic design calculations for the hydrodynamic separator(s) and flow diversion structure(s) as specified herein.

The hydrodynamic separator shall be assembled and installed in strict compliance with the Manufacturer's instructions unless otherwise directed by these specifications or by the Engineer. Internal flow controls / diversion components, external appurtenances, concrete manhole riser sections, manhole frames and covers, reinforcing, threaded inserts, lifting and seating fixtures, non-shrink grout, and all other necessary materials and equipment to complete the work shall be included.

This item shall also include the cleaning of the hydrodynamic separator of all sediment and debris every 90 days, or as needed, from when they are put into service, until final acceptance of the project.

Approved Products and Manufacturer Information: Proprietary hydrodynamic separators currently approved by the Department are listed in Table 1 "**CONNDOT LIST OF APPROVED HYDRODYNAMIC SEPARATORS**". Company contact information is provided for convenience. *As the company information frequently changes, the Department is not responsible for its accuracy.*

The Engineer will reject any proposed hydrodynamic separator that is not listed in Table 1.

The listed products have been approved for use on Department projects based on only a general review of the product's construction, function and treatment capabilities. **Therefore, the approved list shall not be construed to mean that all products appearing on the list are suitable to any specific project site or drainage design.**

Performance: The stormwater treatment performance of the selected hydrodynamic separator shall be based on the water quality flow (WQF) as defined and calculated in accordance with the Department's current version of the Drainage Manual.

The hydrodynamic separator shall be designed to treat the entire WQF as indicated on the contract drawings or specifications, without bypass, either through the separator's internal components or at the flow diversion structure.

TABLE 1 – CONNDOT LIST OF APPROVED HYDRODYNAMIC SEPARATORS

HYDRODYNAMIC SEPARATOR PRODUCT NAME	COMPANY INFORMATION
Downstream Defender	Hydro International 94 Hutchins Drive Portland, Maine 04102 (207) 756-6200 http://www.hydrointernational.biz/us/index_us.php
FloGard Dual-Vortex Hydrodynamic Separator	KriStar Enterprises, Inc. 4020 Riverclub Drive Cumming, Georgia 30041 (770)-889-4338 http://www.kristar.com/
High Efficiency CDS	Contech Stormwater Solutions 200 Enterprise Drive Scarborough, Maine 04074 (800)-925-5240 http://www.contech-cpi.com/stormwater/13
Vortechs	
Vortsentry	
Hydroguard	Hydroworks, LLC 525Boulevard Kenilworth, NJ 07033 (888)-290-7900 / (908)-272-4411 http://www.hydroworks.org/
Stormceptor OSR	Rinker Materials – Stormceptor 69 Neck Road Westfield, MA 01085 (800)-909-7763 / (413) 246-7144 www.rinkerstormceptor.com
Stormceptor STC	
V2B1	Environment 21 8713 Read Road, P.O. Box 55 East Pembroke, New York 14056-0055 (800)-809-2801 / (585)-815-4700 www.env21.com

Hydrodynamic separator systems and models that have been pre-approved for use on Department projects and their corresponding maximum allowable WQF's for stormwater treatment are shown in **Table 2**, "**PERFORMANCE MATRIX FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS**". The Engineer will reject any proposed hydrodynamic separator system/model that is not listed in Table 2.

For more severe storm events that produce flows up to and including the drainage design flow (DDF) and which result in flows greater than the WQF being directed to the hydrodynamic separator from the flow diversion structure, the hydrodynamic separator shall be capable of conveying the portion of the DDF directed to it without surcharging the upstream storm drainage system and re-suspending previously trapped sediment.

The WQF to be treated and the portion of the DDF directed to the hydrodynamic separator when the drainage system is operating at its design flow are shown on the Hydrodynamic Separator

Design Data Sheets (Form A - Design). A separate form for each hydrodynamic separator site on the project is attached to this specification.

Sediment Storage Capacity: Settleable solids shall accumulate in a location within the hydrodynamic separator structure that is accessible for cleaning and maintenance but not susceptible to resuspension. Direct access through openings in the precast concrete unit shall be provided to the sediment storage chamber and all other chambers to facilitate maintenance.

The standard sediment storage capacities for Department pre-approved hydrodynamic separator systems/models are shown in **Table 3**, "**STANDARD SEDIMENT STORAGE CAPACITY FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS**". The sediment storage capacities listed in Table 3 are values based on standard structure dimensions and anticipated maintenance requirements.

Some standard hydrodynamic separator models may be modified as determined by the Manufacturer to increase the sediment storage capacity. When a modification is proposed by increasing the depth of the standard structure, the sediment storage capacity of the proposed structure shall be determined in accordance with **Table 4, "SEDIMENT STORAGE CAPACITY CALCULATION"**.

The Contractor shall be responsible for verifying the standard sediment storage capacity of the hydrodynamic separator unit(s) and coordinating any proposed modifications to increase sediment storage capacity with the Manufacturer(s). All proposed modifications and revised sediment storage capacity determinations shall be clearly documented in the working drawing submission to the Department.

The minimum sediment storage capacities required for each hydrodynamic separator site on the project are shown on the Hydrodynamic Separator Design Data Sheets (Form A – Design) attached to this specification.

Hydraulic Design: The Contractor shall prepare or have prepared a hydraulic grade line (HGL) analysis for an evaluation of the selected hydrodynamic separator and the design of the flow diversion structure as described in this section. The HGL analysis shall be performed for both the WQF and the DDF. The analysis shall be consistent with the methodology described in Section 11.12 of the Department's Drainage Manual.

Head loss coefficients, to be used in the HGL analysis, shall be determined in accordance with Section 11.12.6 for all structures except the hydrodynamic separator, which shall be obtained from the Manufacturer. Documentation shall be submitted demonstrating how the coefficient was derived either through calculation and/or testing data. A benching factor of 1.0 shall be applied to the flow diversion structure.

The HGL analysis (or portion of) that was performed for the design of the storm drainage systems and preparation of the construction plans, including the design of the flow diversion structure and evaluation of a "generic" hydrodynamic separator, is shown on the Hydrodynamic Separator Design Data Forms (Form A – Design) attached to this specification.

TABLE 2 - PERFORMANCE MATRIX FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS

Maximum WQF (cfs)	Product Model								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
0.4	4-ft	DVS-36	2015-4G; 2015-4	HG 4	065	450	1000	VS30	2
0.5	4-ft	DVS-36	2015-4G; 2015-4	HG 4	065	900	1000	VS30	2
0.6	4-ft	DVS-36	2015-4G; 2015-4	HG 4	065	900	1000	VS40	2
0.7	4-ft	DVS-48	2015-4G; 2015-4	HG 4	140	900	1000	VS40	2
0.8	4-ft	DVS-48	2015-4G; 2015-4	HG 4	140	900	1000	VS40	2
0.9	4-ft	DVS-48	2015-4G; 2015-4	HG 4	140	1200	1000	VS40	3
1.0	4-ft	DVS-48	2015-4G; 2015-4	HG 4	140	1800	1000	VS40	3
1.1	4-ft	DVS-48	2015-4G; 2015-4	HG 4	140	1800	1000	VS40	4
1.2	6-ft	DVS-48	2015	HG 5	140	2400	1000	VS50	4
1.3	6-ft	DVS-60	2015	HG 5	140	2400	1000	VS50	4
1.4	6-ft	DVS-60	2015	HG 5	140	2400	2000	VS50	4
1.5	6-ft	DVS-60	2020	HG 5	140	2400	2000	VS50	6
1.6	6-ft	DVS-60	2020	HG 5	140	2400	2000	VS50	6
1.7	6-ft	DVS-60	2020	HG 5	250	2400	2000	VS50	6
1.8	6-ft	DVS-60	2020	HG 6	250	2400	2000	VS50	7
1.9	6-ft	DVS-60	2020	HG 6	250	3600	2000	VS60	7
2.0	6-ft	DVS-60	2020	HG 6	250	3600	2000	VS60	7
2.1	6-ft	DVS-60	2020	HG 6	250	3600	2000	VS60	9
2.2	6-ft	DVS-72	2025	HG 6	250	3600	2000	VS60	8
2.3	6-ft	DVS-72	3020, 3020-D	HG 6	250	3600	2000	VS60	8
2.4	6-ft	DVS-72	3035; 3035-D	HG 6	250	4800	2000	VS60	8
2.5	6-ft	DVS-72	3035; 3035-D	HG 6	250	4800	3000	VS60	10
2.6	6-ft	DVS-72	3035; 3035-D	HG 6	250	4800	3000	VS60	11
2.7	6-ft	DVS-72	3035; 3035-D	HG 7	250	4800	3000	VS60	11
2.8	6-ft	DVS-72	3035; 3035-D	HG 7	250	4800	3000	VS70	11
2.9	6-ft	DVS-72	3035; 3035-D	HG 7	250	4800	3000	VS70	12
3.0	6-ft	DVS-72	3035; 3035-D	HG 7	390	4800	3000	VS70	12

TABLE 2 - PERFORMANCE MATRIX FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS (continued)

Maximum WQF (cfs)	Product Model								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
3.1	8-ft	DVS-72	3035; 3035-D	HG 7	390	4800	3000	VS70	12
3.2	8-ft	DVS-72	3035; 3035-D	HG 7	390	4800	3000	VS70	12
3.3	8-ft	DVS-72	3035; 3035-D	HG 7	390	4800	3000	VS70	14
3.4	8-ft	DVS-72	3035; 3035-D	HG 7	390	6000	3000	VS70	14
3.5	8-ft	DVS-72	3030; 3030-DV, 3030-D; 4030-D	HG 7	390	6000	3000	VS70	14
3.6	8-ft	DVS-72	4030	HG 7	390	6000	3000	VS70	14
3.7	8-ft	DVS-84	4030	HG 8	390	6000	3000	VS70	14
3.8	8-ft	DVS-84	4030	HG 8	390	6000	4000	VS70	13
3.9	8-ft	DVS-84	4030	HG 8	390	7200	4000	VS70	15
4.0	8-ft	DVS-84	4030	HG 8	390	7200	4000	VS80	15
4.1	8-ft	DVS-84	4030	HG 8	390	7200	4000	VS80	15
4.2	8-ft	DVS-84	4030	HG 8	390	7200	4000	VS80	16
4.3	8-ft	DVS-84	4030	HG 8	390	7200	4000	VS80	16
4.4	8-ft	DVS-84	4030	HG 8	390	7200	4000	VS80	16
4.5	8-ft	DVS-84	4030	HG 8	390	7200	4000	VS80	16
4.6	8-ft	DVS-84	5640-D	HG 8	390	7200	4000	VS80	17
4.7	8-ft	DVS-84	5640-D	HG 8	390	7200	4000	VS80	17
4.8	8-ft	DVS-84	5640-D	HG 8	390	7200	4000	VS80	17
4.9	8-ft	DVS-84	5640-D	HG 8	390	11000s	4000	VS80	17
5.0	8-ft	DVS-84	5640-D	HG 9	390	11000s	4000	VS80	19
5.2	8-ft	DVS-84	4040-D	HG 9	390	11000s	4000	VS80	20
5.4	8-ft	DVS-96	4040-D	HG 9	390	11000s	4000	VS100	20
5.5	8-ft	DVS-96	4045-D	HG 9	390	11000s	5000	VS100	18
5.6	8-ft	DVS-96	4045-D	HG 9	560	11000s	5000	VS100	18
6.0	8-ft	DVS-96	4040	HG 9	560	11000s	5000	VS100	18
6.1	8-ft	DVS-96	4040	HG 9	560	11000s	5000	VS100	21

TABLE 2 - PERFORMANCE MATRIX FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS (continued)

Maximum WQF (cfs)	Product Model								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
6.3	8-ft	DVS-96	4040	HG 9	560	11000s	5000	VS100	25
6.4	10-ft	DVS-96	4040	HG 9	560	11000s	5000	VS100	25
6.5	10-ft	DVS-96	4040	HG 10	560	11000s	5000	VS100	25
6.9	10-ft	DVS-96	4040	HG 10	560	11000s	5000	VS100	25
7.0	10-ft	DVS-96	4040	HG 10	560	11000s	5000	VS100	22
7.1	10-ft	DVS-96	5042-D	HG 10	560	11000s	5000	VS100	22
7.2	10-ft	DVS-96	5042-D	HG 10	560	13000s	5000	VS100	22
7.3	10-ft	DVS-96	4045	HG 10	560	13000s	5000	VS100	22
7.5	10-ft	DVS-96	5653-D	HG 10	560	13000s	7000	VS100	22
7.7	10-ft	DVS-120	5653-D	HG 10	560	13000s	7000	VS100	22
7.8	10-ft	DVS-120	5653-D	HG 10	560	13000s	7000	VS100	50
7.9	10-ft	DVS-120	5653-D	HG 10	780	13000s	7000	VS100	50
8.0	10-ft	DVS-120	5658-D	HG 10	780	13000s	7000	VS100	50
8.2	10-ft	DVS-120	5658-D	HG 10	780	16000s	7000	VS100	50
8.5	10-ft	DVS-120	5658-D	HG 12	780	16000s	7000	VS100	50
8.6	10-ft	DVS-120	5658-D	HG 12	780	16000s	7000	VS100	50
8.9	10-ft	DVS-120	5678-D	HG 12	780	16000s	7000	VS100	50
9.0	10-ft	DVS-120	5678-D	HG 12	780	16000s	7000	VS120	50
9.2	10-ft	DVS-120	5678-D	HG 12	780	16000s	7000	VS120	50
9.5	10-ft	DVS-120	5050-DV	HG 12	780	16000s	7000	VS120	50
9.6	10-ft	DVS-120	5050-DV	HG 12	780	16000s	7000	VS120	50
10.0	10-ft	DVS-120	5050-DV	HG 12	780	16000s	9000	VS120	50
10.1	10-ft	DVS-120	5050-DV	HG 12	780	16000s	9000	VS120	50
10.5	10-ft	DVS-120	5050-DV	HG 12	780		9000	VS120	50
10.9	10-ft	DVS-120	5050-DV	HG 12	780		9000	VS120	50
11.0	10-ft	DVS-120	7070-DV	HG 12	780		9000	VS120	50
11.2	10-ft	DVS-120	7070-DV	HG 12	1125		9000	VS120	50

TABLE 2 - PERFORMANCE MATRIX FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS (continued)

Maximum WQF (cfs)	Product Model								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
11.5		DVS-120	7070-DV	HG 12	1125		9000	VS120	50
11.8		DVS-120	7070-DV	HG 12	1125		9000	VS120	50
11.9		DVS-120	7070-DV	HG 12	1125		9000	VS120	60
12.0		DVS-120	7070-DV	HG 12	1125		9000	VS120	60
12.1		DVS-120	7070-DV	HG 12	1125		9000	VS120	60
12.5		DVS-120	7070-DV	HG 12	1125		11000	VS120	60
13.0		DVS-120	7070-DV		1125		11000	VS120	60
13.5		DVS-120	7070-DV		1125		11000	VS120	60
13.6		DVS-120	7070-DV		1125		11000	VS120	60
14.0		DVS-144	7070-DV		1125		11000	VS120	60
14.5		DVS-144	7070-DV		1125		11000		60
14.9		DVS-144	7070-DV		1125		11000		60
15.0		DVS-144	7070-DV		1125		16000		60
15.5		DVS-144	7070-DV		1125		16000		60
15.7		DVS-144	7070-DV		1125		16000		60
16.0		DVS-144	7070-DV				16000		60
16.5		DVS-144	7070-DV				16000		60
17.0		DVS-144	7070-DV				16000		
17.5		DVS-144	7070-DV				16000		
18.0		DVS-144	7070-DV				16000		
18.5		DVS-144	7070-DV				16000		
19.0		DVS-144	7070-DV				16000		
19.7		DVS-144	7070-DV				16000		
20.0		DVS-144	10060-DV				16000		
21.5		DVS-144	10060-DV				16000		
22.3		DVS-144	10060-DV				1319		
25.0			10060-DV				1319		
25.2			10060-DV				1319		

TABLE 2 - PERFORMANCE MATRIX FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS (continued)

Maximum WQF (cfs)	Product Model								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
27.6			10060-DV				1421		
29.3			10080-DV				1421		
30.0			10080-DV				1522		
31.2			10080-DV				1522		
33.6			100100-DV				1522		
35.0			100100-DV				1624		
38.2			100100-DV				1624		
40.0			100100-DV				1726		
43.2			100100-DV				1726		
49.3			100100-DV						

TABLE 3 - STANDARD SEDIMENT STORAGE CAPACITY FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS

Sediment Storage (cubic yards)	**Product Model**								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
0.3		DVS-36					1000		
0.5	4-ft								
0.6							2000		
0.7		DVS-48		HG 4					
0.8					065	450		VS30	2; 3
0.9			2015-4G; 2015-4						
1.0 (minimum)							3000		
1.1					140	900			
1.2				HG 5					
1.3		DVS-60							
1.4							4000	VS40	
1.5			2015; 2020; 2025						
1.6									4
1.7				HG 6					
1.8	6-ft					1200			
1.9							5000		
2.0									
2.1									
2.2		DVS-72						VS50	
2.3				HG 7					
2.4									6; 7
2.5							7000		
2.6			3020, 3020-D; 3030, 3030-DV, 3030-D; 3035, 3035-D						
2.9					250	2400			

TABLE 3 - STANDARD SEDIMENT STORAGE CAPACITY FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS (continued)

Sediment Storage (cubic yards)	**Product Model**								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
3.0				HG 8					
3.1							9000	VS60	
3.2									8; 9
3.3						1800			
3.4									
3.5		DVS-84							
3.6									
3.7	8-ft		5640-D						
3.8				HG 9					
3.9							11000		
4.0									
4.2									10; 11; 12
4.3			4030-D; 4040-D; 4045-D					VS70	
4.5									
4.6									
4.7									13
5.0				HG 10					
5.1									
5.3		DVS-96	5042-DV; 5050-DV						
5.5									
5.6			4030; 4040; 4045; 5653-D; 5658-D; 5678-D				16000	VS80	
5.7									
6.0						3600			
6.5									

TABLE 3 - STANDARD SEDIMENT STORAGE CAPACITY FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS (continued)

Sediment Storage (cubic yards)	Product Model								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
6.6							1319		
6.9									
7.0									
7.1									
7.2									
7.3									14; 15; 16; 17; 18
7.5				HG 12					
7.6							1421		
7.7									
8.0									
8.3									
8.4			7070-DV						
8.6						4800			
8.7	10-ft				390		1522	VS100	
9.0									
9.5									
9.6									
9.9							1624		
10.0									
10.3		DVS-120							
10.5									19; 20
11.0									
11.2							1726		
11.3						6000			
11.5									21; 22
11.8									

TABLE 3 - STANDARD SEDIMENT STORAGE CAPACITY FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS (continued)

Sediment Storage (cubic yards)	Product Model								
	Downstream Defender	*Flogard*	*High Eff. CDS*	*Hydroguard*	*Stormceptor OSR*	*Stormceptor STC*	*Vortechs*	*Vortsentry*	*V2B1*
12.0									
12.6								VS120	25
12.9					560				
13.0									
13.4						7200			
15.0									
17.5					780				
17.8		DVS-144	10060-DV;10080-DV; 100100-DV						
20.0									
22.3									50
25.0									
25.8					1125				
26.1						11000s			
26.2									
30.0									
34.1						13000s			
34.9									60
35.0									
38.7									
40.0									
40.7						16000s			

TABLE 4 - SEDIMENT STORAGE CAPACITY CALCULATION

Product	Sediment Storage Capacity (Volume) Calculation (cubic feet)
Downstream Defender	Inside Diameter (ft^2) of Structure x Distance (ft) from Bottom of Benching Skirt to Inside Floor of Structure
FloGard® Dual-Vortex	Inside Diameter (ft^2) of Structure x 1/2 Distance (ft) from Bottom of Vortex Tube to Inside Floor of Structure
High Efficiency CDS	Inside Diameter (ft^2) of Structure x Depth (ft) of Solids Storage Sump
Hydroguard	Inside Diameter (ft^2) of Structure x 1/2 Depth (ft) Below Outer Baffle Wall
Stormceptor STC	Inside Diameter (ft^2) of Structure x 1/2 Depth (ft) Below Drop Tee Inlet Pipe
Stormceptor OSR	Inside Diameter (ft^2) of Structure x 1/2 Depth (ft) Below Drop Tee Inlet Pipe
Vortechs	Inside Diameter (ft^2) of Grit Chamber x 1/2 Depth (ft) Below Opening in Swirl Wall
Vortsentry	Inside Diameter (ft^2) of Structure x Depth (ft) of Sediment Storage Sump
V2B1	Inside Diameter (ft^2) of Structure (D1) x 1/2 Depth (ft) Below Pipe Invert
Note: 1 cubic foot = 0.037 cubic yard or 1 cubic yard = 27 cubic feet	

Since the selected hydrodynamic separator and associated connecting pipes and structures may be different in type, configuration and performance than the one assumed in the design phase of the project, the hydraulic calculations performed for the drainage design must be replicated and revised to reflect any adjustments necessary to the drainage design for installation of the selected system, such as different flow-line elevations, head loss coefficient, pipe sizes, etc. The selected hydrodynamic separator shall be designed so as not to change the drainage system upstream of the flow diversion structure or to increase the HGL elevation upstream of the flow diversion structure. Any modifications necessary to the overall drainage design as a result of the Contractor selected hydrodynamic separator shall be the responsibility of the Contractor.

The new HGL analysis must demonstrate the following conditions:

1. The hydrodynamic separator can treat the WQF with no bypass. The HGL elevation at the flow diversion structure for the WQF shall be below the weir elevation and/or elevation of flow bypass that is listed in the design data form or shown in the plans, so that all of the WQF is directed to the hydrodynamic separator for treatment. The HGL elevation in the hydrodynamic separator at the WQF shall be below the elevation of internal bypass so that all of the WQF is treated by the system.

2. When the drainage system is operating at the DDF, the hydraulic computations must show that the HGL elevation at the flow diversion structure is lower than or equal to the HGL elevation shown on Form A for the DDF and the HGL elevation in the hydrodynamic separator must be a minimum of one foot below the top (ground) elevation of the structure. A HGL elevation in the flow diversion structure for the DDF which is higher than the corresponding HGL elevation shown on Form A may be approved by the Engineer only if hydraulic computations are submitted showing that the higher HGL elevation will provide a minimum of one foot of freeboard below the top (ground) elevation of the flow diversion structure and the upstream drainage structures, satisfying the design criteria stated in the Connecticut Department of Transportation Drainage Manual. To demonstrate compliance, the hydraulic analysis shall be extended to a point upstream in the drainage system that is not influenced by the proposed changes and where the results converge with the previous design analysis. In such a case, the Contractor shall request a copy of the design analysis from the Department. A freeboard less than one foot may be accepted by the Engineer on a case by case basis provided that a justification of the reason has been included with the HGL analysis.

3. When the drainage system is operating at the DDF, the resulting HGL elevation and flow split at the flow diversion structure has been designed such that the portion of the DDF directed to the hydrodynamic separator does not exceed the maximum flow shown on the Hydrodynamic Separator Design Data Sheets (Form A - Design). Documentation, however, must be provided that the flow in excess of the WQF can pass through the device without washout of the previously captured sediment or the device is equipped with an internal bypass to route the excess flow around the treatment chamber.

Upon conclusion of the HGL analysis, the Hydrodynamic Separator Design Data Sheets (Form B – Contractor Proposal) shall be completed by entering the HGL analysis data and other required information.

Hydrodynamic Separator Selection: To ensure compliance with the special provision, the selection process of a proprietary hydrodynamic separator for installation on a Department project is outlined by the following steps:

1. First, select the available product(s) from Table 2 (**PERFORMANCE MATRIX FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS**) that meet or exceed the WQF treatment specified on the Hydrodynamic Separator Design Data Sheets (Form A - Design) attached to this specification. **The Engineer shall reject any proposed hydrodynamic separator system/model that is not listed in Table 2.**

2. Using Table 3 (**STANDARD SEDIMENT STORAGE CAPACITY FOR CONNDOT APPROVED HYDRODYNAMIC SEPARATORS**), check whether the initially selected product(s) in Step 1, meet or exceed the minimum sediment storage requirement specified on the Hydrodynamic Separator Design Data Sheets (Form A - Design). In some cases, the required sediment storage capacity will govern the model size required for the project. In lieu of selecting a larger model to accommodate the sediment storage requirement, the Contractor may submit working drawings as recommended by the Manufacturer, showing how a standard model has been modified to satisfy the sediment storage requirement. When a modification is proposed by increasing the depth of the standard structure, **Table 4 (SEDIMENT STORAGE CAPACITY CALCULATION)** shall be utilized to determine the sediment storage capacity of the proposed structure.

3. **Hydrodynamic separator system/models pre-approval by the Department shall not be construed to mean that all products appearing on Tables 2 and 3 are suitable to any specific project site or drainage design.** The Contractor shall verify the constructability of the selected hydrodynamic separator in relation to dimensional, structural, geotechnical and right-of-way constraints at each installation site. If revisions to the drainage design, including the system layout, are required to accommodate the selected separator, the Contractor shall provide working drawings showing the revised layout, including the position of the hydrodynamic separator and the number, positions and types of connecting structures, the design of the flow diversion structure, and any other components of the system within the pay limits. The working drawings shall be prepared in sufficient detail to perform a hydraulic analysis and confirm that the layout will fit the constraints of each site.

4. Upon determination that the WQF, sediment storage and constructability requirements have been met, the Contractor shall prepare or have prepared, a HGL analysis in accordance with the hydraulic requirements of this special provision, that includes the selected hydrodynamic separator and any revisions to the drainage design needed for the installation.

5. The Hydrodynamic Separator Design Data Sheets (Form B – Contractor Proposal) shall be completed and signed by a professional engineer licensed by the State of Connecticut.

6. *Acceptance of the computations by the Engineer must be obtained by the Contractor prior to the purchase or installation of any units.*

Materials: Materials utilized to fabricate, construct and install the precast concrete hydrodynamic separator including but not limited to precast concrete units, brick, concrete masonry units, manhole frames and covers shall meet the requirements specified in the Standard Specifications, Form 816, Article M.08.02, except that the 28 day compressive strength specified in Subarticle M.08.02-4, shall be a minimum of 4000 psi (27.6 MPa).

The Contractor shall provide a Materials Certificate in accordance with 1.06.07 for each unit delivered to the project. Upon request, the Contractor shall also provide Certified Test Reports for the fine and coarse aggregates and all cementitious materials, and the concrete mix design indicating the weight of each component, used in the construction of the precast units for review. The structures shall not be shipped until released by the Contractor's Quality Control Manager or designee.

The wall and slabs of the precast concrete units shall be designed to sustain HS20-44 (MS18) loading requirements.

Manholes and Catch Basins shall conform to Section 5.07 of Form 816.

Granular fill shall conform to the requirements of Article M.02.01 of Form 816.

Non-shrink grout shall conform to the requirements of Subarticle M.03.01-12 of Form 816.

Drainage pipe, sealant and gaskets shall conform to the requirements of Article M.08.01 of Form 816.

Mortar shall conform to the requirements of Article M.11.04 of Form 816.

Sealant used for the hydrodynamic separator unit(s) shall be resistant to oil and other hydrocarbons and conform to the requirements of ASTM C-443.

Working Drawings: Working drawings in accordance with Article 1.05.02 – 2 shall be required for the system selected by the Contractor. The working drawings shall include the HGL analysis and all other computations in strict accordance with the "Hydraulic Design" section of this special provision, including a completed Form B – Contractor Proposal.

If revisions to the layout of the system within the payment limits of this item are required to accommodate the selected separator, the working drawings shall also include plans that show the required revisions. These plans shall show the revised position of the hydrodynamic separator unit(s), and all revisions to connecting structures, pipes, elevations, and details, including the

design within the flow diversion structure. The revised plans shall also include the pay limit showing all the components of the system that are included in this lump sum pay item.
Working drawings shall also show details for construction, reinforcing joints, internal and external components, any cast-in-place appurtenances, locations and elevations of pipe openings, access manhole locations and elevations, and type / method of sealing pipe entrances.

Working drawings for each hydrodynamic separator on the project shall have all appropriate vertical dimensions referenced with elevations that are consistent with the project plans. In addition to any other structural, material or installation requirements, the working drawings shall clearly indicate the following information:

1. The elevation and flow rate when internal flow bypass would occur within the device.

2. The location, dimensions and volume (capacity) of the sediment storage area within the device.

The working drawings shall be sealed by a professional engineer licensed in the state where the devices are manufactured and that said engineer shall certify the device meets the minimum requirements of the ConnDOT Standards.

The working drawing submission by the Contractor shall consist of the following documents:

1. Working drawings for each hydrodynamic separator proposed for installation on the project.

2. Hydraulic design calculations including the head loss documentation and completed Hydrodynamic Separator Design Data Sheets (Form B – Contractor Proposal) with professional engineer signature for each hydrodynamic separator.

3. Copies of the pertinent construction plan, profile, cross section and detail sheets that have been annotated with any proposed drainage revisions that are required for the installation of the proposed hydrodynamic separator(s). If no changes are required, the submittal shall note same.

4. An Operations and Maintenance Manual for each hydrodynamic separator describing operations, inspection, maintenance procedures and any applicable warranty information.

Acceptance of the working drawing submission by the Engineer must be obtained by the Contractor prior to the fabrication of each hydrodynamic separator and diversion structure.

Construction Methods: The Contractor shall inspect the hydrodynamic separator and any accessory equipment upon delivery for general appearance, dimensions, soundness or damage in a manner acceptable to the Engineer. If any defects or damage are identified by the inspection, the unit shall be rejected by the Contractor and a new undamaged hydrodynamic separator shall be supplied. Any required adjustments of the separator shall be completed in accordance with

Manufacturer's recommendations. A Manufacturer's representative and the Engineer will inspect the hydrodynamic separator before installation.

The Contractor shall install the hydrodynamic separator structure in accordance with the Manufacturer's recommendations unless otherwise directed by this specification or by the Engineer. The hydrodynamic separator shall be installed plumb, level and aligned both vertically and horizontally with the inlet and outlet piping. The hydrodynamic separator shall be placed on a compacted granular fill base in accordance with the Manufacturer's specifications or a minimum thickness of 6" (150mm) whichever is larger. Anchoring systems shall be installed, where needed, to resist buoyancy forces. Care shall be taken not to damage the hydrodynamic separator during backfill and compaction.

Pipe openings in the hydrodynamic separator shall be sized to accept pipes of the specified size(s) and material(s) as shown on the contract drawings and shall be sealed by the Contractor in accordance with the requirements of this specification. The inlet and outlet pipe connections shall be watertight. The hydrodynamic separator shall be tested for leakage according to the Manufacturer's specifications and to the satisfaction of the Engineer. Any leaks must be found and corrected to the satisfaction of the Engineer prior to acceptance of the structure.

Access openings with manhole frames and covers shall be provided to all chambers of the hydrodynamic separator. The access openings and pipe openings shall be detailed on the working drawings to be submitted by the Contractor for review and acceptance by the Engineer.

All connecting structures and pipes included within the payment limits for this work shall be constructed in accordance with the applicable requirements of Article 5.07.03 and Article 6.51.03.

Method of Measurement: Design, construction, furnishing, installation and cleaning of the hydrodynamic separator, the flow diversion structure, manholes and pipes as shown on the contract drawings, including all internal and external appurtenances and materials used, will be paid for on a lump sum basis per site.

Basis of Payment: This work will be paid for at the contract lump sum for "HYDRODYNAMIC SEPARATOR", complete in place, which price shall include all work within the pay limits shown on the contract drawings for hydrodynamic separator. If revisions to the layout of the system within the payment limits for this item are required to accommodate the selected separator, the lump sum price shall also include all additional or revised connecting structures and pipes. The contract lump sum shall include, but not be limited to, the following:

1. Design, preparation, revisions of working drawings and hydraulic computations.

2. Concrete and reinforcing steel, sealant, cement, mortar, flexible rubber sleeves, internal and external components, brick and masonry, frames and covers used to construct access manholes.

3. Flow diversion structure, manholes and pipes as shown on the contract drawings, or as revised and shown on submitted working drawings accepted by the Engineer.

4. Structure excavation, back fill, and disposal of surplus material.

5. Compacted granular fill.

6. Trench excavation and bedding material.

7. Cleaning of the Hydrodynamic Separator, flow diversion structure, manholes and pipes as shown on the contract drawings (of all debris every 90 days, or as needed), during the duration of the project, shall also be included in the price of this item.

8. The Operations and Maintenance Manual for each hydrodynamic separator.

The price shall include but not be limited to all materials, testing, equipment, tools and labor incidental thereto.

Attachments: The following documents are attached to this specification:

1. Hydrodynamic Separator Design Data Sheets (Form A – Design), Sheets 1 & 2 of 2.

2. Hydrodynamic Separator Design Data Sheets (Form B – Contractor Proposal), Sheets 1 & 2 of 2 (blank), to be completed and submitted with the working drawings.

ITEM #0507190A – OUTLET CONTROL STRUCTURE 1

ITEM #0507191A – OUTLET CONTROL STRUCTURE 2

ITEM #0507192A – OUTLET CONTROL STRUCTURE 3

ITEM #0507193A – OUTLET CONTROL STRUCTURE 4

Description: Work under this item shall include furnishing and installing a precast concrete outlet control structure where indicated, complete with components in conformance with approved shop drawings, manufacturer's specifications, and to the size, lines and grades shown on the plans, or as directed by the Engineer.

Materials: All materials to be used in the precast concrete outlet control structure shall conform to the requirements of Section 5.07.02 and be in conformance with, approved shop drawings, manufacturer's specifications or as directed by the Engineer, and the following:

Compacted granular fill shall conform to the requirements of Section M.02.01.

The weir plate shall be cast-in-place concrete and shall conform to the requirements of Article M.03.01 for Class "F" concrete.

Construction Methods: The precast concrete outlet control structure shall be constructed in conformance with the requirements of Section 5.07.03 and the following:

The weir plate shall be constructed in accordance with Section 6.01.03. The outlet control structure shall not be placed upon frozen or muddy subgrades. Bedding for the precast concrete outlet control structure shall conform to the requirements set forth by the manufacturer with approval of the Engineer. Excavation for the outlet control structure shall be in accordance with Section 2.05.

Method of Measurement: Installation of the precast outlet control structure, including all internal and external appurtenances and materials used, will be measured for payment by each individual unit installed and accepted in place and shall include all necessary pipe connections. There will be no measurement or direct payment for the application of protective compound material and granular fill used for installation, but the cost of this work shall be considered as included in the general cost of the work.

Trench Excavation will be measured for payment in accordance with Section 2.05.04

Basis of Payment: This item will be paid for at the contract unit price each for "Outlet Control Structure", complete in place, which price shall include all materials, equipment, tools, and labor

incidental thereto. This item shall also include granular fill, precast concrete outlet structure, protective compound, mortar, internal components, and frames and covers.

Excavation will be paid for as "Trench Excavation" in accordance with the provisions of Section 2.05.05.

Pay Item	Pay Unit
Outlet Control Structure X	ea.

ITEM #0507460A – UNDERGROUND DETENTION SYSTEM NO. 1

ITEM #0507461A – UNDERGROUND DETENTION SYSTEM NO. 2

ITEM #0507462A – UNDERGROUND DETENTION SYSTEM NO. 3

ITEM #0507463A – UNDERGROUND DETENTION SYSTEM NO. 4

ITEM #0507464A – UNDERGROUND DETENTION SYSTEM NO. 5

Description: Work under this item shall include furnishing and installing all necessary materials for the construction of underground detention systems at the locations shown on the plans, complete, in conformance with approved shop drawings, manufacturer's specifications, and to the size, lines and grades shown on the plans, or as directed by the Engineer. Necessary materials include manholes, High Density Polyethylene Pipe (corrugated polyethylene pipe (Type S)), crushed stone, geotextile, sand and backfill material as shown on the plans. Also included in this item is all necessary excavation, disposal of surplus material, formation of subgrade and backfilling.

Materials: Materials to be used in the underground detention systems shall conform to the following:

Manholes shall conform to the requirements of Section 5.07.02 and, if precast, be in conformance with, approved shop drawings, manufacturer's specifications or as directed by the Engineer.

High Density Polyethylene Pipe (corrugated polyethylene pipe (Type S)) shall conform to the requirements of Subarticle M.08.01.25.

Crushed stone shall meet the requirements for No. 4 stone in Section M.01.01.

Geotextile shall conform to the requirements of Section 7.55.02.

Sand shall meet the requirements for bedding material in Section M.08.01-21.

Backfill material shall conform to the requirements of Section 2.07.02.

Construction Methods: Construction methods for the components of the underground detention systems shall be in accordance with the following:

Manholes shall be constructed in accordance with Section 5.07.03.

High Density Polyethylene Pipe (corrugated polyethylene pipe (Type S)), crushed stone and sand shall be installed in accordance with Section 6.51.03.

Geotextile shall be installed in accordance with Section 7.55.03.

Excavation, disposal of surplus material and backfill material shall be installed in accordance with the pertinent sections of Section 2.05.03.
Formation of subgrade shall be performed in accordance with Section 2.09.03.

Method of Measurement: In accordance with the pay limits noted below, construction and installation of the underground detention systems, including all appurtenances and materials used, will be measured for payment by each individual system installed and accepted in place in the locations shown on the plans, or as directed by the Engineer. There will be no measurement or direct payment for manholes directly in-line with the system header pipes, system header pipes, system pipes, crushed stone, geotextile, sand, excavation, disposal of surplus material, formation of subgrade, or backfilling. The cost of this work shall be considered as included in the general cost of the work.

Horizontal Pay Limits: The horizontal pay limit for each underground detention system shall be 1.5 feet outside of the system header pipe and 2 feet outside of the neat lines of the foundations where manholes are proposed.

Vertical Pay Limits: The lower vertical pay limit for each underground detention system shall be the bottom of the crushed stone as shown on the plans.

The upper vertical pay limit for each underground detention system shall be the bottom of the parking lot pavement structure.

Basis of Payment: This item will be paid for at the contract unit price each for "Underground Detention System No. X", complete in place, which price shall include all materials, equipment, tools, and labor incidental thereto. There will be no separate payment for manholes directly in-line with the system header pipes, system header pipes, system pipes, crushed stone, geotextile, sand, excavation, disposal of surplus material, formation of subgrade, or backfilling.

Pay Item	Pay Unit
Underground Detention System No. X	ea.

ITEM #0507901A – LAWN DRAIN

ITEM #0507902A – LAWN DRAIN – FLAT GRATE

ITEM #0507903A – LAWN DRAIN – 5' DIAMETER

ITEM #0507904A – LAWN DRAIN – 8' DIAMETER

ITEM #0507905A – LAWN DRAIN – 24" GRATE

Description: Work under this item shall include the construction of lawn drains, all in conformity with the lines, grades, dimensions and details shown on the plans, or as ordered, and in accordance with the provisions of these specifications for the various materials and work which constitute the completed structure.

Materials: The materials to be used in the construction of the lawn drains shall be in accordance with the requirements of Section 5.07.02.

The beehive frame and grate shall be Neenah Foundry Catalog No. R-2560-EA, or approved equal.

Construction Methods: The construction methods for the lawn drains shall be in accordance with the requirements of Section 5.07.03.

Method of Measurement: The method of measurement for the lawn drains shall be in accordance with the requirements of Section 5.07.04.

Basis of Payment: The basis of payment for the lawn drains shall be in accordance with the requirements of Section 5.07.05.

Pay Item	Pay Unit
Lawn Drain	ea.

ITEM #0507910A – AREA DRAIN

Description: Work under this item shall include the construction of area drains, all in conformity with the lines, grades, dimensions and details shown on the plans, or as ordered, and in accordance with the provisions of these specifications for the various materials and work which constitute the completed structure. PVC surface drainage inlets shall include the drain basin type as indicated on the contract drawing and referenced within the contract specifications. The ductile iron grates for each of these fittings are to be considered an integral part of the surface drainage inlet and shall be furnished by the same manufacturer. The surface drainage inlets shall be as manufactured by Nyloplast a division of Advanced Drainage Systems, Inc., or approved equal.

Materials: The materials to be used in the construction of the area drains shall be in accordance with the requirements of Section 5.07.02.

The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.

The grates and frames furnished for all surface drainage inlets shall be ductile iron for sizes 8”, 10”, 12”, 15”, 18”, 24” and 30” and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting H-20 wheel loading for traffic areas or H-10 loading for pedestrian areas. 12” and 15” square grates will be hinged to the frame using pins. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black.

Construction Methods: The construction methods for the area drains shall be in accordance with the requirements of Section 5.07.03.

The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements of class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be placed and compacted uniformly in accordance with ASTM D2321. The drain basin body will be cut at the time of the final grade. No brick, stone or concrete block will be required to set the grate to the final grade height. For H-20 load rated installations, a concrete ring will be poured under and around the grate and frame. The concrete slab must be designed taking into consideration local soil conditions, traffic loading, and other

applicable design factors. For other installation considerations such as migration of fines, ground water, and soft foundations refer to ASTM D2321 guidelines.

Method of Measurement: The method of measurement for the area drains shall be in accordance with the requirements of Section 5.07.04.

Basis of Payment: The basis of payment for the area drains shall be in accordance with the requirements of Section 5.07.05.

Pay Item	Pay Unit
Area Drain	ea.

ITEM #0601651A - RETAINING WALL (SITE NO. 1)

ITEM #0601652A - RETAINING WALL (SITE NO. 2)

ITEM #0601653A - RETAINING WALL (SITE NO. 3)

ITEM #0601654A – RETAINING WALL (SITE NO. 4)

Description: This item will consist of constructing a retaining wall in the location, grades, and to the dimensions and details shown on the contract drawings, and in accordance with these specifications.

The wall shall only be a cast-in-place reinforced concrete retaining wall as shown on the contract drawings. The use of proprietary retaining walls on this project is not an option.

This item will also include all labor, material and work incidental to the installation of the handrail associated with Retaining Wall (Site No. 1) and Retaining Wall (Site No. 2).

Design: Design computations are not required for the cast-in-place wall detailed on the contract drawings except for any temporary earth retaining systems included in the lump sum item. The Contractor shall submit working drawings and design computations for temporary earth retaining systems in accordance with Article 7.14.03.

Materials:

The materials furnished and used in the work shall be those prescribed within Section 5.06 of the Standard Specifications for Roads, Bridges and Incidental Construction, including supplemental specifications and applicable special provisions.

a. Concrete: The concrete shall conform to the requirements of Section M.03.01 and as follows:

Concrete for all precast components shall be air-entrained composed of portland cement, fine and coarse aggregates, admixtures and water. The air-entraining feature may be obtained by the use of either air-entraining portland cement or an approved air-entraining admixture. The entrained-air content shall be not less than four percent or more than seven percent. The concrete utilized shall be a mix which will attain a minimum 28-day strength (f'_c) of 4,500 pounds per square inch. The mix design shall be furnished to the Engineer.

Concrete for footings or unreinforced leveling pads shall be conform to the requirements of Class "A" Concrete. Class "F" Concrete shall be used for cast-in-place concrete copings.

Concrete Finish: Unless otherwise indicated on the contract drawings or elsewhere in the specifications, the concrete surface for the exposed face shall have an ordinary steel form finish. All non-exposed surfaces shall have a unformed finish which shall be free of open pockets of aggregate and surface distortions in excess of 1/4 inch.

Acceptance Criteria for Precast Components: Precast components shall be accepted for use in wall construction provided the concrete strength meets or exceeds the minimum compressive strength requirement, the soil reinforcement connection devices and the panel or module dimensions are within the manufacture's allowable tolerances and any chipping, cracks, honeycomb or other defects are within acceptable standards for precast concrete or repaired as determined by the Engineer.

It is recognized that certain cracks and surface defects are not detrimental to the structural integrity of the precast components if properly repaired. The Engineer shall determine the need for and proper method of such repair. All repairs shall be approved by the Engineer prior to acceptance of the precast component for use in wall construction.

Marking: The date of manufacture, the production lot number, and the piece-mark shall be clearly marked on the side of each panel or module.

b. Reinforcing Steel: Reinforcing steel shall conform to the requirements of ASTM A615, Grade 60.

c. Joint Materials: All horizontal and vertical joints between panels shall be covered by a geotextile (separation-high survivability) conforming to the requirements of Article M.08.02-26. The minimum width and lap shall be twelve inches. Details of installation including connection of the geotextile to coping shall be provided.

d. Backfill: Backfill shall be pervious structure backfill conforming to the requirements of Articles M.02.05 and M.02.06.

e. Metal Handrail: Metal handrail associated with the steps and landings of Retaining Wall (Site No. 2) shall conform to the requirements of Section 9.14.02.

e. Chain Link Fence: Chain link fence associated with Retaining Wall (Site No. 1) shall conform to the requirements of Section 9.13.

All fence materials, including but not limited to the fabric, posts and hardware, shall meet the requirements of Section 9.13.02 and be black polyvinyl chloride (PVC) – coated.

The pipe sleeve, to be cast in the top of the retaining wall, shall meet the requirements of Subarticle M.06.02-8.

Bituminous coating material, to be applied to the inside of the pipe sleeve and outside of the post, shall meet the requirements of Subarticle M.08.01-5.

The epoxy chemical anchoring system, to fill the void between the pipe sleeve and the post, shall meet the requirements of Subarticle M.03.01-15.

Construction Methods:

Construction methods shall be in accordance with the detailed requirements prescribed for the construction of cast-in-place retaining walls and concrete for steps and copings as specified in Section 5.06.03 of the Standard Specifications for Roads, Bridges, and Incidental Construction.

Construction methods for the installation of the metal handrail associated with Retaining Wall (Site No. 1) and Retaining Wall (Site No. 2) shall be in accordance with the detailed requirements prescribed in Section 9.14.03 of the Standard Specifications for Roads, Bridges, and Incidental Construction.

Method of Measurement: This work will be paid for on a lump sum basis and will not be measured for payment.

Basis of Payment: This work will be paid for at the contract lump sum for "RETAINING WALL (SITE NO. X)", complete in place, which price shall include all work shown within the pay limits shown on the contract drawings for the retaining wall including but not limited to the following:

1. Excavation required for the construction of the retaining wall.

2. Design and construction of temporary earth retaining systems to retain the existing facilities during construction.

3. The furnishing and installation of metal handrail.

4. The furnishing and installation of wall-mounted chain link fence.

5. The furnishing, placing and compacting of pervious structure backfill within the payment lines.

6. The furnishing and placing of backfill drainage systems for the wall.

7. The furnishing and placing of rigid metal conduit, junction boxes, light standard anchorages, and other electrical appurtenances located within the wall proper.

8. Any other work and materials shown on the plans for the retaining wall.

The price shall also include all materials, equipment, tools and labor incidental thereto.

If bedrock or boulders in excess of one cubic yard are encountered in the excavation, it shall be paid for under the item "Structure Excavation - Rock".

ITEM #0603169A – PROGRESS PHOTOGRAPHS

Description: Under this item, the Contractor shall engage a qualified commercial photographer to take photographs during construction. The photographer shall be a firm or an individual of established reputation that has been regularly engaged as a professional photographer for not less than 3 years.

At the Preconstruction Meeting, submit to the Designer for approval the name of the photographer whom will be responsible for taking the photographs during construction.

Submit photos of each view within seven (7) calendar days of taking photographs. Four (4) photographic sets of photos shall be submitted. ALL photos shall be submitted in IBM-PC compatible digital format on compact disc (CD). Other than the photo thumbnail index required for submission with each CD, no other hardcopy photos shall be required for the project. One (1) set of photos (on CD) of each submittal shall be sent directly to each of the following offices:

1. Manager of State Design, Office of Facilities Design, Connecticut Department of Transportation, 2800 Berlin Turnpike, P.O. Box 317546, Newington, CT 06131-7546, Attention: Mr. Scott A. Hill, Room 3405NW.
2. District 1 Construction, Connecticut Department of Transportation, Project Chief Inspector's Construction Trailer.
3. Bureau of Public Transportation, Office of Rail, Connecticut Department of Transportation, 2800 Berlin Turnpike, P.O. Box 317546, Newington, CT 06131-7546.

Each CD and CD jewel case shall be labeled with the name of the project, State project number, name of the Contractor, date of submission, and name and address of the photographer.

Materials: Provide digital images in IBM-PC compatible JPEG format, with uncompressed (open) image size equal to or greater than the following dimensions: Pixel Dimensions = 1596 x 2000; Resolution = 200 pixels/inch. JPEG compression for each image shall equal "Quality 7" (High). Images shall be color (RGB mode).

Digital Cameras used for the purpose of creating the above noted image files shall have a minimum sensor size of 3.3 million pixels.

Image files shall be named and a photo thumbnail index created with the following file naming convention: *Project number date of submission_photo number.jpg*

For example: If the first set of photos on CD for project number 0402-0002, is submitted on 12/13/01, the first photo of the submission shall be file named: 04020002_121301_1.jpg and the tenth photo of the set shall be file named: 04020002_121301_10.jpg. In the second set of photos on CD, submitted 1/12/02, the first photo of the set shall be file named: 04020002_011202_1.jpg

A hardcopy “Photo Thumbnail” index shall be provided with each CD submission. The photo thumbnails shall be printed on 8 ½” x 11” “glossy photo quality” ink jet paper with a minimum 720 dot-per-inch ink jet printer. The thumbnail images shall be a minimum 200 x 250 pixels at 200 pixel per inch resolution. The file names shall be located under each image. The thumbnail images shall be arranged so that they can all be contained on a single 8 ½-in by 11-in inkjet print. *For example*, 35 images would be arranged in five (5) columns and seven (7) rows. The CD shall also contain the digital file of the photo thumbnail index in jpeg format. The file shall share the same format as the above noted photo file format but the word “index” shall be placed in the location of the photo number. *For example*: 04020002_121301_index1.jpg

A hardcopy 8 ½" x 11" key plan with an arrow for each photograph taken shall be provided with each CD submission. Each arrow shall be labeled with the corresponding photograph number and shall be oriented to show the point of view of the photograph.

In lieu of using a digital camera to provide the above noted image files, standard 35 mm cameras and 35 mm color negative film may be used to take the images, and the images may then be captured as a digital file through the use of a designated 35mm film scanner. The 35mm scanner must have the following minimum specifications: 2700 dot per inch optical resolution; 3.4 Dmax; 36 bit color depth. The use of flatbed scanners shall not be permitted for this purpose.

Project progress photos shall be submitted as digital files on write-once CD-ROM in a jewel case on a monthly basis. **All subsequent CD submissions shall include the image files of the previous submissions and an updated hardcopy of the photo thumbnail index that contains all current and previous photos.**

Construction Methods: Where used herein, one set of photographs will be defined as Thirty Five (35) photographs.

Before starting construction, take one set of color photographs of the site and surrounding properties from different points of view as selected by the Engineer. Take photographs to show existing conditions to the property before starting Work. Take photographs of existing buildings either on or adjoining the property in sufficient detail to record accurately the physical conditions at the start of construction.

Take one set of color photographs at no greater than monthly intervals, coinciding as closely as possible with the completion of a major construction phase. The photographer shall select the vantage points for each shot each month to best show the status of construction and progress since the last photographs were taken. Prior to taking any photographs, review the proposed vantage points for each shot with the Engineer. Photographs are for a record of the progress of work. Therefore, they shall be taken at a maximum interval of one month, whether or not they show any completion of work performed during the preceding month.

Take one set of color photographs upon notification by the Engineer of Final Inspection of the Project. Prior to taking any photographs, review the proposed vantage points for each shot with

the Engineer. Take photographs from opposing views of the site in an effort to display various characteristics of the new construction.

Method of Measurement: This work will be measured for payment by the number of photographic sets submitted to the Engineer. "Each" photographic set shall be defined as Thirty Five (35) photographs. For purposes of bidding, the pay unit for a photographic set shall be "Each."

Basis of Payment: This work will be paid for at the Contract unit price each for "Progress Photographs" which price shall include all material, equipment, and labor incidental thereto. Where any submission's image files do not conform to the requirements herein, the Contractor shall not receive any payment for the item.

Pay Item	Pay Unit
Progress Photographs	ea.

ITEM #0651743A – 6" POLYVINYL CHLORIDE PIPE

ITEM #0651744A – 8" POLYVINYL CHLORIDE PIPE

ITEM #0651745A – 10" POLYVINYL CHLORIDE PIPE

ITEM #0651746A – 12" POLYVINYL CHLORIDE PIPE

ITEM #0651747A – 15" POLYVINYL CHLORIDE PIPE

Work under this item shall conform to the requirements of Section 6.51, supplemented as follows:

Description: Add the following after the last sentence in Paragraph 1:

"Also included in this item is the furnishing and installing of cleanouts, of the type and size noted on the Plans or as ordered by the Engineer, not located within a perimeter five (5) feet from the outside of the foundation wall."

Materials: Add the following paragraph at the end of the section:

"Cleanouts shall be fabricated using wyes and bends of the same size and pipe material as the drain pipe itself. Solid wall pipe shall be used for vertical pipes and fittings. Furnish heavy duty frames and covers for cleanouts as indicated on the plans."

Construction Methods: Add the following paragraph at the end of the first section, before the sub-section entitled "For Slotted Drain Pipe":

"Cleanouts shall be installed as detailed on the plans. Provide a minimum of five (5) inches of concrete cover over the riser section."

Method of Measurement: Add the following after the last sentence in Paragraph 1. "New and Re-laid Pipe Culverts and Pipe-Arch Culverts":

"Where pipe enters the station building, pipe will not be measured for payment within a perimeter located five (5) feet from the outside of the foundation wall. Cleanouts will not be measured for payment whether or not they are within a perimeter five (5) feet from the outside of the foundation wall."

Basis of Payment: Add the following after the last sentence in Paragraph 1. "New Pipe Culverts and Pipe-Arch Culverts":

"The cost of pipe within the perimeter located five (5) feet from the outside of the foundation wall for the station building is included in the MLSI "Rail Facility Upgrade". The cost of

cleanouts within the perimeter located five (5) feet from the outside of the foundation wall for the station building is included in the MLSI "Rail Facility Upgrade". The cost of cleanouts not located within a perimeter five (5) feet from the outside of the foundation wall of the station building shall be considered incidental to the cost of the pipe of the same type and size."

ITEM #065___A – 6" HDPE PIPE – TOP HALF PERFORATED

ITEM #065___A – 8" HDPE PIPE – TOP HALF PERFORATED

Description: This item shall consist of the installation of 6" and 8" High Density Polyethylene Pipe – Perforated (corrugated polyethylene pipe (Type SP)) with perforations on the top half only.

Materials: Shall conform to the requirements for High Density Polyethylene Pipe – Perforated (corrugated polyethylene pipe (Type SP)) under Subarticle M.08.01-25 with the following provision:

"Only the top half of the pipe shall be perforated. Bottom half of pipe shall be smooth interior surface without perforations."

Construction Methods: Construction methods for this work shall conform to Section 6.51.03.

Method of Measurement: Shall be measured for payment in accordance with Article 6.51.04.

Basis of Payment: Shall be paid for in accordance with Article 6.51.05.

ITEM # 0714026A - TEMPORARY SHEET PILING (RAILROAD)

7.14.01 - Description:

Add the following paragraph to the existing paragraph:

The contractor shall comply with all railroad specifications, including CSI Section 02261A of the project specifications, contained elsewhere herein. The requirements and conditions set forth in the subject specifications shall be binding on the contractor just as any other specification would be.

7.14.05 - Basis of Payment:

Replace the only paragraph with the following:

Payment for this work will be made at the contract unit price per square feet for "Temporary Sheet Piling (Railroad)," measured as described above, which price shall include all design, materials, equipment and labor incidental to the construction and removal of the temporary sheet piling required at the locations specified on the plans; including removal of obstructions, repair and correction, adjustments or reconstruction required by the plans. Any common sheet piling wall required for stage construction will be measured for payment only once. In no case will a given length or portion of temporary sheet piling be measured for payment more than once. Sheet piling ordered left in place will have an additional payment at the contract unit price per square feet for "Sheet Piling Material Left in Place (Railroad)."

Pay Item	Pay Unit
Temporary Sheet Piling (Railroad)	S.F.

ITEM #0728009A – 2″ CRUSHED STONE

Description: This item shall consist of furnishing and placing washed crushed stone in the locations and to the dimensions show on the plans or as ordered in accordance with these specifications.

Materials: Washed crushed stone shall be composed of durable crushed rock consisting of angular fragments, free from a detrimental quantity of thin, flat, elongated pieces or shall be durable crushed gravel stone obtained by artificial crushing of gravel boulders or fieldstone. The crushed stone shall be free from clay, loam, or deleterious material.

Washed Crushed Stone shall conform to the following gradation:

	Percent Passing by Weight
Sieve Size	2-inch Stone
2 inch	90 – 100
1-1/2 inch	-
1-1/4 inch	25 – 50
1 inch	-
¾ inch	0 – 15
½ inch	0 – 5
No. 4	-

Construction Methods: The crushed stone shall be placed and shall be shaped to the dimensions shown on the plans or as ordered by the Engineer. The stone shall be placed by any suitable means which will not crush the stone and shall be shaped to a smooth uniform finished surface.

Method of Measurement: 2″ Crushed Stone shall be measured for payment by the actual number of cubic yards completed and accepted.

Basis of Payment: This work will be paid for at the contract unit price per cubic yard for "2″ CRUSHED STONE" completed in place and accepted, which price shall include all equipment, tools, labor and materials incidental thereto.

Pay Item	Unit
2″ Crushed Stone	CY

ITEM #0728020A - STONE BALLAST

Description:

This Section specifies the material requirements for ballast to be furnished and placed by the Contractor in accordance with the Plans and Specifications. This Section also includes furnishing all labor, materials and equipment necessary and incidental to placing ballast as directed by the Engineer.

Materials:

The Contractor shall submit, under the provisions of this Section, the following information:

Compliance: Supplier's certification that the material delivered to the site is in compliance with the Specifications.

Samples: Submit as one representative sample and one sample of each new source of supply as requested by Engineer. Samples of not less then 150 lbs should be submitted.

References:

The Contractor shall comply with provisions of Codes, Specifications, Standards, and recommended practices of the most recent edition and addenda thereto of:

AREMA: American Railway Engineering and Maintenance of Way Association, Manual for Railway Engineering

ASTM International (formerly American Society for Testing and Materials)
ASTM: C 29, C 88, C 117, C 127, C 131, C 136, C 142, C535, D 75, D 4791 and E11.

AASHTO: American Association of State Highway and Transportation Officials

Ballast Requirements:

Testing and inspection shall conform to the AREMA Manual.

Material not meeting the Specifications shall not be used in the work.

Furnish prepared ballast that is of crushed rock, hard, strong, angular, durable particles, containing no carbonates or slag, free from injurious amounts of deleterious substances.

The ballast shall have a minimum Sand Equivalent of 50 when measured by California Test 217.

Determination of weight per cubic yard shall be in accordance with ASTM C29.

All particles of the ballast shall have been broken by the crusher and have at least two broken surfaces.

All boulders which will pass through a 5-inch circular opening before crushing shall be rejected.

Type A ballast shall be crushed trap rock or granite. It shall: a) be composed of angular fragments which are clear and free from deleterious substance; b) have proper gradation; and c) meet all requirements of this specification. Additionally, ballast shall be in conformance with AREMA Chapter 1, Part 2 except as otherwise specified herein.

Ballast shall conform to the following scale when tested with laboratory sieves having square openings. (Sieves must conform to ASTM E11):

Size No.	Ballast Type	Nominal Size Sq. Openings	Amounts Finer Than Each Sieve (Sq. Opening Laboratory Sieve- Pct. by Wgt) 2"	1½"	1"	3/4"	½"	3/8"	No.4
4	A	1½" - 3/4"	100	90-100	20-55	0-15		0-5	
5	A	1" - 3/8"		100	90-100	40-75	15-35	0-15	0-5

Deleterious substances in ballast shall not be present in excess of the following amounts:

Description:	Percent by Weight:
Soft and friable pieces	3.0 percent
Material finer than No. 200 Sieve	0.5 percent
Clay lumps	0.5 percent

Hardness shall be between 5.5 and 7.0 as measured on Moh Hardness scale.

Water absorption shall not exceed 1.2% when tested in accordance with ASTM C127.

Type A ballast chemical analysis shall reveal quantitatively that at least 70% of test sample is composed of silicon dioxide, aluminum oxide, and iron oxide, but that not more than 25% of test sample is comprised of magnesium oxide, magnesium carbonate and calcium carbonate.

The Contractor shall be responsible for assuring ballast cleanliness. A suitable washing facility shall be provided at the quarry for this purpose. This facility shall consist of a high pressure spray over the ballast as it passes on the belt. A quality control plan along with washing procedures must be submitted with Contractor's quotation. The QC plan and washing procedures will be subject to approval by the Engineer.

Prepared ballast shall be handled in such a manner that it is kept clean and free from segregation. It shall be only loaded into cars which are in good order, tight enough to prevent leakage and waste of material, and clean and free from rubbish or any substance which would foul the ballast.

L.A. Abrasion	Type "A"
Percent of wear shall not exceed grading of sample	14.6

When L.A. abrasion is in excess of 13.0% wear, cementing value in pounds per square inch shall not exceed 375.

The quality of stone for ballast from any quarry or new strata opened up, including its soundness, resistance to abrasion, chemical composition, absorption, impedance, hardness and weight per cubic foot, shall be determined prior to its acceptance at a testing laboratory selected by the purchaser. Each stratum or portion of quarry containing a variation of quality of stone shall be tested separately and not averaged. Quality tests and gradation tests shall subsequently be made from time to time as deemed necessary by the purchaser to control the quality and size of ballast furnished by the producer.

Sufficient visual observations, determinations of deleterious substances and analyses of gradation shall be made by the producer prior to shipment to assure compliance with these specifications.

The Contractor shall provide certified results of tests required by specifications. The Engineer reserves the right to witness the performance of tests. If the Contractor desires to use its own testing facilities to make the aforementioned tests, the Engineer's concurrence must be received.

The Sieve Analysis shall be made in accordance with the Method of Tests for Sieve Analysis of Fine and Course Aggregate (ASTM Designation C136).

Los Angeles Abrasion Loss shall be treated in accordance with Method of Test for Abrasion of Course Aggregate by use of the Los Angeles Machine (ASTM Designation C131) except that Grading of the sample for testing shall be as follows:

Sieve Size - Square Openings Passing	Retained On	Weight in Grams
2"	1¾ "	1250
1¾"	1½"	1250
1½"	1¼"	1250
1¼"	1"	1250

Soundness shall be treated in accordance with the current Method of Test for Soundness of Aggregate by use of Sodium Sulfate (ASTM Designation C88).

Percent of loss shall not exceed 5.

Cementing values shall be tested in accordance with the Logan Walter Page Method (U.S. Department of Agriculture, Bulletin No. 347, 1916, Page 15) except as modified as follows:

1. 500 grams of fines developed from the Los Angeles Abrasion Test (ASTM C131) that has been screened through a 100 mesh sieve, mixed with sufficient water, kneaded for five minutes and allowed to stand in air tight container for two hours, thereby forming a stiff dough that is to be molded into cylindrical briquettes 1 inch diameter by 1 inch in height under pressure of 1877.5 pounds per square inch, after which they are dried for 20 hours in air at room temperature, 4 hours in a hot air bath at a temperature of 212°F, then cooled for 20 minutes in a desiccator, and immediately tested in a compression testing machine for static crushing strength, the bearing heads being suspended by pivots to secure uniform distribution of load which is applied at 600 pounds per minute approximately.

2. The average crushing strength in pounds per square inch of 5 specimens measures the cementing value of this stone.

The Contractor shall certify that ballast delivered to the Railroad is typical of that upon which specified tests have been made.

The selection of samples is as important as the laboratory testing, and care must be taken that the samples obtained show the true nature and conditions of the material to be examined.

Samples of all ballast and samples of stone at quarries for test to determine the acceptability of the source, as well as samples for quality control, shall be selected by a representative of the purchaser. The owner of the quarry or producer may submit samples for inspection or preliminary testing if such action is approved by the Engineer.

Samples of the finished product for gradation and other required tests shall be taken from each 1,000 tons of prepared ballast unless otherwise ordered by the Engineer. Samples shall be representative (full belt) and shall weigh not less than 100 pounds. Where the acceptability of stone from a quarry is to be determined, a 150 pound sample consisting of pieces of approximately 6 by 6 by 4 inches should also be furnished. Method of sampling shall be furnished to the Engineer for approval.

If material prior to, during or after being loaded, does not conform to specifications, Inspector shall notify Contractor to stop operations until all faults have been corrected. Disposal and/or removal of defective material shall be done without cost to the Railroad.

As it is impractical to inspect all ballast at quarry, the Engineer reserves the right to reject any car of ballast (whether previously inspected or not) that does not conform to specifications upon arrival at unloading site.

No ballast shall be unloaded unless it has been approved by the Engineer or agency authorized by the Railroad to test and approve ballast.

Should ballast that does not meet specifications be unloaded prior to the Engineer's approval, then payment will not be made to Contractor. Contractor must remove all defective material from site without cost to the Railroad.

Defective material arriving at site for unloading shall be rejected by the Engineer and disposed of at expense (including all freight and switching costs) of Contractor.

Construction Methods:

Do not place ballast until the Engineer has approved the subgrade upon which the ballast is to be placed.

The Contractor shall place stone ballast to the limits and depths, and to the grade, shown on the Plans, or as directed by the Engineer. Unless otherwise indicated or directed, ballast shall be placed to 1'-7" below top of rail elevation. Ballast above that elevation will be placed by Amtrak.

The ballast layer shall be thoroughly compacted until the surface is true and unyielding, displaying no deformation or movement under the compaction equipment. Compact ballast to 100-percent maximum density by vibratory compaction equipment specifically manufactured for compaction purposes, or self-propelled pneumatic-tired roller. Self-propelled, pneumatic-tired roller shall have a gross weight of 10- to 15-tons. Vibratory compactor shall have a weight of not less than 10-tons and be capable of applying a dynamic load of not less than 18,000-pounds at 1,300- to 1,500-cpm. .

Leave top of ballast bed flat and level to within plus or minus 1-inch across a 12-foot wide platform centered on the track centerline. After installation of ballast layer, refrain from driving vehicles on the ballast layer that would foul ballast or cause center-binding of ties. Replace any ballast that has become fouled by mud or fine materials at no cost to ConnDOT or Amtrak.

Method of Measurement:

All aggregate required for this work shall be weighed on scale furnished by and at the expense of the Contractor, except as otherwise permitted herein. The scales shall be of a type satisfactory to the Engineer and shall be sealed, at the expense of the Contractor, as often as the Engineer may require. All weighing shall be done in the presence of a representative of the Engineer.

If material is shipped by rail, ballast shall be ordered and payment based upon net ton in carload lots. Adjustments to compensation shall be made for deficiencies in plan depth and cross section as specified herein.

Cars shall be weighed and such weights shall be forwarded with car numbers to the Engineer.

If weighing cars is impractical, weight per cubic yard shall be obtained by weighing sample cubic yard volumes at such intervals as the Engineer may designate. Weight per cubic yard obtained by

such tests, amount of cubic yards loaded in each car and car number shall be furnished to the Engineer, and shall be used in calculating weight per car until additional tests are made.

If material is shipped by rail, the car weights may be accepted but scales shall be provided as specified above if the Engineer so directs.

Measurements shall be subject to the following provisions:

Determination of Thickness: The thickness shall be as indicated on the plans, or as ordered by the Engineer and within a tolerance of minus three-quarters of an inch (-¾") to plus one-half inch (+½").

Measurements to determine the thickness will be taken by the Engineer at intervals of 500 feet or less, and shall be considered representative of the lane.

If a thickness measurement is taken and found deficient, the Engineer will take such additional measurements as he considers necessary to determine the longitudinal limits of the deficiency.

The Engineer may waive an occasional measurement outside the tolerances if in his judgment it is not representative of true conditions and providing that:

(a) Other thickness measurements taken nearby for the course are within acceptable limits;

(b) proper controls have been exercised by the Contractor; and

(c) if there would be no impairment to the serviceability of the complete construction.

No adjustment of the quantity accepted for payment will be made where the thickness does not exceed the allowable plus or minus tolerances.

Where the thickness exceeds that indicated on the plans by more than the prescribed tolerance, that material which is in excess of the total planned depth, plus the tolerance, will not be included for payment.

Areas represented by measurements deficient in thickness in excess of the allowable minus deviation shall be corrected at the Contractor's expense, or with written permission of the Engineer, the deficient areas may remain, and payment will be made at an equitable adjusted price based on weight per cubic yard.

An adjustment in quantity will be made in the materials placed beyond the horizontal limits indicated on the plans by deducting the computed weight of that material extending more than three inches beyond the horizontal plan dimensions.

Basis of Payment:

This work will be paid for at the contract unit price per ton for “Stone Ballast”, complete in place, which price shall include all materials, tools, equipment and work incidental thereto.

Pay Item	Pay Unit
Stone Ballast	ton

ITEM #0811005A – CONCRETE WHEEL STOP

Description: Work specified under this article shall consist of furnishing and placing concrete wheel stop at the locations specified in the contract plans.

Materials: Furnish precast concrete wheel stops approximately 7 inches high, 10 inches wide, and 6 feet long, as shown on the contract drawings. Concrete shall be air entrained with a minimum compressive strength of 2,500 psi. Provide chamfered corners and drainage slots on the underside.

Construction Methods: Secure wheel stops to hot-mixed asphalt surface with not less than two #5 steel dowels embedded in precast concrete at 9 inches from each end. Dowels shall be epoxy coated and 2 feet 7 inches long.

Method of Measurement: This work will be measured for payment by the number of concrete wheel stops, of the type specified, installed and accepted.

Basis of Payment: This work will be paid for at the Contract unit price each for "Concrete Wheel Stop", of the type specified, compete in place, which price shall include the precast concrete wheel stop, steel dowels, and all materials, equipment, tools and labor incidental thereto.

Pay Item	Pay Unit
Concrete Wheel Stops	EA

ITEM #0901003A - STEEL BOLLARD

Description:

This item shall consist of furnishing and installing steel bollards in concrete footing, of the size specified, at the location, to the dimensions and details as shown on the plans in accordance with these specifications, or as directed by the Engineer.

Materials:

Material for this work shall conform to the following requirements:

Steel Pipe: 6" I.D., Schedule 80, Galvanized in accordance with ASTM F1083

Concrete: Class "C" Concrete, in accordance with Section M.03.01

Granular Fill: Compacted, in accordance with Section 2.14

Paint (Finish Coat): Polyerethane, E.I. DuPont Imron 3.5 HG, Tnemec 1074 Series Endura-Shield II, or Carboline Carbothane 133 HB, black and yellow in color, in accordance with Section M.07

Paint (Primer): Manufacturer's recommendation compatible with finish coat, in accordance with Section M.07

Construction Methods:

Excavation shall be in accordance with Section 2.02.

Compacted granular fill shall be in accordance with Section 2.14.

The steel bollards shall be constructed to the dimensions shown on the plans. The steel pipe shall be set in a concrete footing of at least 24 inches in diameter. In lieu of a footing, the entire hole shall be filled with concrete. If installed in a grass area, the top six (6) inches of the hole shall be backfilled with a comparable material. The post shall be filled with concrete. The top shall be rounded to a convex surface. No sharp edges, burrs, threads or other defects shall be exposed.

The post shall be painted in accordance with the manufacturer's recommendations.

Method of Measurement:

This work shall be measured for payment by the actual number of steel bollards installed and accepted in place.

Excavation, backfill and disposal of surplus material will not be measured for payment, but the cost shall be included in the price bid for the steel bollard.

Compacted granular fill will not be measured for payment, but the cost shall be included in the price bid for the steel bollard.

Basis of Payment:

This work will be paid for at the contract unit price each for "Steel Bollard", complete in place, which price shall include all excavation as specified, backfill, disposal of surplus material, granular fill, steel pipe, paint, concrete and all material, equipment, tools, and labor incidental thereto.

Concrete sidewalk adjacent to the bollards shall be paid for at the contract unit price per square foot for “Concrete Sidewalk”.

ITEM #0905 A – ALUMINUM FENCE

Description: Work under this item shall consist of furnishing and installing six (6) feet high aluminum, fixed louver, modular fencing, gates and accessories as shown on the plans, or as directed by the Engineer, and in accordance with these specifications.

Materials: The aluminum, fixed louver, modular fencing shall be the "Titan", as manufactured by Ametco Manufacturing Corporation, 4326 Hamann Parkway, P.O. Box 1210, Willoughby, OH, 44096, USA, 800-321-7042, or approved equal.

Aluminum fence panels, posts, and gates shall have a polyester powder coating factory finish. Color shall be "Bronze Mat", by Ametco, or approved equal.

Accessories shall be the manufacturer's recommended to complete the fencing system.

Concrete for anchorages shall be Class "A" and shall meet the requirements of Article M.03.01.

Construction Methods: The Contractor shall verify areas to receive fencing are completed to final grades and elevations prior to installation and shall ensure that all property lines and legal boundaries of work are clearly established.

Aluminum, fixed louver, modular fencing, gates and accessories shall be installed in accordance with the manufacturer's recommendations.

Terminal and gate posts shall be set in a concrete footing a minimum of 12 inches in diameter. Line posts, if recommended by the manufacturer, shall be set in a concrete footing a minimum of 10 inches in diameter. Concrete footings shall be a minimum of 24' in depth and posts shall have a minimum embedment into the concrete footing of eight (8) inches. Posts shall be installed plumb, level and secure using hardware supplied by the manufacturer. Hardware shall be adjusted to ensure smooth operation.

Each post shall be checked for vertical and top alignment, and its position shall be maintained during placement and finishing operation.

Post caps and other accessories required shall be installed to complete the fence system.

The Contractor shall submit shop drawings in accordance with the State of Connecticut, Form 816, Article 1.05.02. For further information, refer to NOTICE TO CONTRACTOR – SUBMITTALS.

Special Warranty

The Manufacturer agrees to repair or replace fencing whose factory finish fails for cracking, peeling and blistering, under normal use, for a period of 10 years from the date of Substantial Completion.

Method of Measurement: "Aluminum Fence", of the height noted, will be measured for payment by the number of linear feet of fence installed and accepted, measured from outside to outside of terminal posts, as shown on the Plans or as ordered by the Engineer.

Gates, within the line of the aluminum fence will be considered part of the aluminum fence and measured for payment by the linear foot as noted above.

Basis of Payment: This work will be paid for at the contract unit price per linear foot for "Aluminum Fence", which price shall include excavation, backfill, fabrication, concrete, disposal of surplus material, resetting, final removal and all materials, equipment, tools, and labor incidental to the furnishing and installation of the aluminum, fixed louver, modular fence system and gates.

Pay Item	Pay Unit
Aluminum Fence	l.f.

ITEM #0913984A – TEMPORARY PROTECTIVE FENCE

Description: Work under this item shall consist of furnishing and installing temporary 8' high chain link fence, including gates, of the type and size as indicated on the Plans, and at the locations shown on the Plans or as ordered by the Engineer. Also included in this item is the resetting, as indicated or as directed by the Engineer, of the temporary chain link fence and gates, and the final removal and disposal following the completion of construction.

The temporary chain link fence shall be installed around the perimeter of the site, and staging areas, as shown on the Plans or as ordered by the Engineer. It shall be used to separate the Contractor's work areas from that of the surrounding public. As well as restricting access to Amtrak's right-of-way.

Materials: The material for the temporary chain link fence and gates, including all hardware and appurtenances, shall conform to the requirements of Article 9.13.02, except that polyvinyl chloride-coated fabric, posts and/or hardware will not be allowed. Temporary gates shall be of the same type of materials used for the adjacent chain link fence. The materials shall include all necessary hardware for swing-type operation.

The materials used shall be new or in good condition, if previously used. Previously used materials require the approval of the Engineer prior to installation.

Concrete for anchorages shall be Class "A" and shall meet the requirements of Article M.03.01.

Construction Methods: Temporary chain link fence and gates shall be installed in accordance with the Plans and Section 9.13.03 of the specifications.

The Contractor shall maintain the fencing in good condition during the construction phase and shall immediately repair any damaged sections. Any temporary chain link fence and/or gates damaged by the Contractor, either during normal construction operations or the resetting process, shall be replaced at the Contractor's expense and at no cost to the State.

The Contractor shall remove the temporary fencing, including concrete anchorages if used, when no longer required for the work, as directed by the Engineer. The Contractor shall backfill all holes with granular material.

Method of Measurement: "Temporary Protective Fence" will be measured for payment by the number of linear feet of temporary fence installed and accepted, measured from outside to outside of terminal posts, as shown on the Plans or as ordered by the Engineer.

Temporary chain link gates, within the line of the temporary chain link fence will be considered part of the temporary chain link fence and measured for payment by the linear foot as noted above.

The resetting of the temporary protective fence for the Contractor to complete the work shown on the plans, to facilitate his needs, or the installation of additional temporary protective fence or gates for the Contractor's convenience will not be measured for payment.

Basis of Payment: This work will be paid for at the contract unit price per linear foot for "Temporary Protective Fence", which price shall include excavation, backfill, fabrication, concrete, disposal of surplus material, resetting, final removal and all materials, equipment, tools, and labor incidental to installing, maintaining, resetting where required and removal.

Pay Item	Pay Unit
Temporary Protective Fence	l.f.

ITEM #0921001A CONCRETE SIDEWALK

Concrete sidewalks shall be constructed in accordance with Article 9.21, supplemented as follows:

Article 9.21.01 - Description: Add the following:

This item shall include furnishing and installing Detectable Warning Strips in the locations and to the dimensions and details shown on the plans or as directed by the Engineer.

Article 9.21.02 – Materials: Add the following:

The Detectable Warning Strip, for new construction, shall be chosen from the Department's Qualified Products Lists. The tile shall conform to the dimensions shown on the plans Manufacturer's specifications and have a brick red homogeneous color throughout in compliance with Federal Standard 595A Color #22144 or approved equal.

Article 9.21.03 – Construction Methods: Add the following:

The Detectable Warning Strip, for new construction, shall be set directly in poured concrete according to the plans and the Manufacturer's specifications and details. The flanges shall be embedded in wet concrete so that after the concrete is cured the surface of the detectable warning strip does not project above the adjacent concrete surface. The Contractor shall place two 25-pound concrete blocks or sandbags on each tile to prevent the tile from floating after installation.

The detectable warning strip shall be installed 6" from the edge of road along the full width of the ramp. The rows of truncated domes in a detectable warning surface shall then be aligned to be perpendicular or radial to the grade break between the ramp, landing, or blended transition and the street.

Article 9.21.04 – Method of Measurement: Add the following:

The Detectable Warning strip will not be measured for payment. All materials, equipment, tools and labor incidental thereto shall be included in the Bid price for Concrete Sidewalk.

Only work installed exterior to the station building and platforms will be measured for payment. Work under this item installed interior to the station building and platforms is included in the MLSI "Rail Facility Upgrade".

Article 9.21.05 – Basis of Payment: Add the following:

Work installed interior to the station building and platforms is included in the MLSI "Rail Facility Upgrade".

ITEM #0921004A – MONOLITHIC CONCRETE SIDEWALK AND CURB

Monolithic Concrete Sidewalk and Curb shall be constructed in accordance with Article 9.21, supplemented as follows:

Article 9.21.01 - Description: Delete in its entirety and replace with the following:

This item shall consist of monolithic concrete sidewalk and curb constructed on an 8" thick processed gravel base course in the locations and to the dimensions and details shown on the plans or as ordered in accordance with these specifications.

This item shall include furnishing and installing Detectable Warning Strips in the locations and to the dimensions and details shown on the plans or as ordered by the Engineer.

Article 9.21.02 – Materials: Add the following:

The Detectable Warning Strip shall be a prefabricated detectable warning surface tile as manufactured from Engineered Plastics Inc. 300 International Drive, Suite 100 Williamsville, NY 14221, telephone number (800) 682-2525 or the approved equal from ADA Fabricators, INC. P.O Box 179 North Billerica, MA 01862 telephone number (978) 262-9900. The tile shall conform to the dimensions shown on the plans and have a brick red homogeneous color throughout in compliance with Federal Standard 595A Color #22144 or approved equal.

Article 9.21.03 – Construction Methods: Add the following:

The curbing and sidewalk are to be formed as one monolithic form so that the curb and sidewalk are poured together. A ½" dummy joint shall be constructed with a jointing tool between the curb and sidewalk as indicated on the details shown on the plans.

The Detectable Warning Strip for new construction shall be set directly in poured concrete according to the plans and the manufacturer's specifications or as directed by the Engineer. The contractor shall place two 25 pound concrete blocks or sandbags on each tile to prevent the tile from floating after installation in wet concrete.

Article 9.21.04 - Method of Measurement:

Section 1. Concrete Sidewalk: Delete in its entirety and replace with the following:

1. **Monolithic Concrete Sidewalk and Curb:** This work will be measured by the actual number of square feet of completed and accepted concrete sidewalk and curb in place. Measurement shall be from face of curb to back of sidewalk.

Add the following:

The Detectable Warning strip will not be measured for payment. All materials, equipment, tools and labor incidental thereto shall be included in the Bid price for Monolithic Concrete Sidewalk and Curb.

Article 9.21.05 – Basis of Payment: Delete in its entirety and replace with the following:

This work will be paid for at the contract unit price per square foot (square meter) for "Monolithic Concrete Sidewalk and Curb," complete in place, which price shall include all excavation as specified above, backfill, disposal of surplus material, gravel or reclaimed miscellaneous aggregate base, equipment, tools, materials and labor incidental thereto.

Pay Item	Pay Unit
Monolithic Concrete Sidewalk and Curb	sf

ITEM #0921033 – GRAVEL WALK

Description: This item shall include furnishing and installing gravel strips and gravel walkways in the locations and to the dimensions and details shown on the plans or as ordered by the Engineer.

Materials: Gravel Walk shall conform to the requirements of Subarticle M.02.03 of the Form 816 for Traffic Bound Gravel Surface.

Construction Methods: Excavation, including removal of any existing sidewalk, shall be made to the required depths below the finished grade, as shown on the plans or as directed by the Engineer. All soft and yielding material shall be removed and replaced with suitable material.

After excavating to the required depth, compact and form the subgrade to the grades and lines as shown on the plans or as directed by the Engineer.

The Gravel Walk shall be placed in layers not to exceed 6 inches in depth and to such a depth that after compaction it shall be at the finished grade of the walk as specified on the plans.

Method of Measurement: This work will be measured by the actual number of square feet of completed and accepted Gravel Walk.

Article 9.21.05 - Basis of Payment: Replace with the following:

Basis of Payment: This work will be paid for at the contract unit price per square foot for "Gravel Walk", complete in place, which price shall include all excavation as specified above, disposal of surplus material, formation of subgrade, equipment, tools, materials and labor incidental thereto.

Pay Item	Pay Unit
Gravel Walk	sf

ITEM #0921050A – CONCRETE PAVERS ON BASE

Description:

Work under this item shall consist of the furnishing of all labor, materials, tools, and equipment necessary to construct concrete paver bands on a gravel base course in the locations and to the dimensions and details shown on the plans or as ordered by the Engineer.

Materials:

The concrete pavers shall conform to the dimensions shown on the plans and have a brick red homogeneous color throughout in compliance with Federal Standard 595A Color #22144 or approved equal.

Gravel for base shall conform to Subarticle M.02.01-01 – Crushed Stone.

Sand Base shall conform to Article M.03.01 of the Standard Specifications.

Construction Methods:

1. **Excavation:** Excavation for installation of the concrete paver bands shall be made to the required depths below the finished grade, as shown on the plans or as directed. All soft and yielding material shall be removed and replaced with suitable material.

2. **Gravel Base:** Gravel base material required to meet the final grades shall be placed and properly compacted ensuring a minimum thickness of 8" is achieved. Dense graded crushed stone shall be laid in two equal 4 inch compacted lifts on a compacted and formed subgrade of suitable material. After compaction of the gravel base, it shall be at the specified depth below the finished grade of the paver band.

3. **Leveling Bed:** The Contractor shall place a layer of sand base course material 1" in thickness on the properly prepared gavel base course. The sand base course shall be thoroughly compacted and present a hard smooth surface.

4. **Concrete Pavers:** After the sand base course has been properly prepared, the concrete pavers shall be placed at the final grades in a pattern specified on the plans or as ordered by the Engineer. The pavers shall be placed as closely together as possible and the sand joints between the pavers shall be no wider than that allowed by the natural texture of the paver itself. No open joints will be allowed.

Method of Measurement:

This work will be measured by the actual number of square feet of concrete pavers on base completed and accepted.

Basis of Payment:

This work will be paid for at the contract unit price per square foot for "Concrete Pavers on Base" complete in place, which price shall include all excavation, disposal of surplus material, grave base, sand base, materials, equipment, tools, and labor incidental thereto.

Pay Item	Unit
Concrete Pavers on Base	sf

ITEM #0947003A – BUS PASSENGER SHELTER

Bus passenger shelters shall be constructed in accordance with Article 9.47, supplemented as follows:

Article 9.47.01 – Description: Delete and replace with the following:

This item shall consist of the furnishing and installation of bus passenger shelters, of the size and type indicated, in the location shown on the plans or as directed by the Engineer.

Article 9.47.02 – Materials: Delete Sub-Sections 1–4 and 6, and replace with the following:

The bus passenger shelter shall be the Reverse Barrel Vault, 96 inches by 192 inches in size, as manufactured by Duo-Gard Industries, Inc,, or approved equal.

The roof shall be standing-seam metal in accordance with the following:

1. Nominal 1 inch standing seam roof panels
2. Fabricate from 0.7mm min. thickness
3. Seams: Standing seams, 16 inches o.c. and as indicated on drawings, non-moving with flat-lock seams
4. Roll size: Half Coils
5. Finish: Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
6. Accessories: Provide components required for a complete weathertight sheet metal roofing assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of sheet metal roofing, unless otherwise indicated.
7. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
8. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
9. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
10. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal. Size shall be as recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

Each shelter shall be equipped with a single free-standing, surface-mounted, straight, five-unit group bench, and shall be the Plexus II Collection by Landscape Forms, or approved equal.

Spare Parts

The following spare parts shall be supplied by the Contractor no later than the date of Substantial Completion:

Safety Glazing Panels: Furnish six (6) additional safety glazing panels in standard size as indicated in the Contract Documents and approved Shop Drawings. Provide panels complete with aluminum sash frame that matches products that are installed and that are packaged with protective covering for storage and identified with labels describing content.

Benches: Furnish three (3) additional benches that match products installed and that are packaged with protective covering for storage and identified with labels describing content.

Article 9.47.03 – Construction Methods: Add the following:

The bus passenger shelters and free-standing, surface-mounted benches shall be installed in strict conformance with the manufacturer's instructions and recommendations.

Special Warranties

Special Warranty: Manufacturer agrees to repair or replace shelters that fail in materials or workmanship for a period of five (5) years from the date of Substantial Completion.

Special Warranty on Benches: Manufacturer agrees to repair finish or replace benches that show evidence of deterioration of factory-applied finishes or that fail in materials or workmanship for a period of five (5) years from the date of Substantial Completion.

Special Warranty on Sheet Metal Roofing Finishes: Manufacturer agrees to repair finish or replace sheet metal roofing that shows evidence of deterioration of factory-applied finishes for a period of 20 years from the date of Substantial Completion.

Special Warranty on Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within a period of five (5) years from the date of Substantial Completion. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

Article 9.47.04 – Method of Measurement: Add the following:

Free-standing, surface-mounted benches will not be measured for payment, but the cost shall be included in the price bid for the bus passenger shelter.

Article 9.47.05 – Basis of Payment: Add the following:

There will be no separate payment for the free-standing, surface-mounted benches. The cost of furnishing and installing these benches shall be included in the contract unit price each for "Bus Passenger Shelter", complete in place, which price shall include all material, equipment, tools, and labor incidental thereto.

ITEM NO. 0949003A – FURNISHING, PLANTING AND MULCHING TREES, SHRUBS, VINES AND GROUND COVER PLANTS

Work under this item shall conform to the latest supplemental requirements of Section 9.49 of the Form 816 and amended as follows:

9.49.02 - Materials: *Add the following:*

Submittals:

The apparent low bidder shall submit to the Manager of Contracts a Schedule of Values within 14 days after bid opening. Any bidder that the Department may subsequently designate as the apparent low bidder shall make the aforesaid submission within 14 days from the date on which the Department notifies said Contractor that has become the low bidder. If, however, the Department deems it necessary for such a submission within a shorter period of time, the Contractor shall make the submission within the time designated by the Department.

The Schedule of Values shall be divided into "Line Items" listed separately by plant type. Each line item shall be assigned a unit price. The sum of the line items in the schedule of Values shall equal the amount bid for the item "Furnishing, Planting and Mulching Trees, Shrubs, Vines, and Ground Cover Plants."

The Schedule of Values shall be in the following format:

Wallingford Station

Plant Type, Variety and Size	Quantity	Unit Cost	Cost
Acer x freemanii 'Armstrong', Armstrong Maple Hybrid, 3"-3.5" B/B	11		
Acer x freemanii 'Autumn Blaze', Autumn Blaze Maple Hybrid, 3"-3.5" B/B	1		
Amelanchier x grandiflora 'Autumn Brilliance' , Autumn Brilliance Serviceberry, 7'-8' B/B clump	1		
Astilbe 'Visions in Red', Visions in Red False Spirea, 2G	24		
Baptista australis 'Purple Smoke', Purple Smoke False Indigo, 2G	11		
Chamaecyparis nootkatensis 'Jubilee', Narrow Weeping Alaskan Cedar, 6'-7' B/B	1		
Coreopsis x 'Full Moon', Full Moon Tickseed, 1G	16		
Cornus alba 'Elegentissima', Variegated Shrub Dogwood, 3G	38		
Cornus alba 'Ivory Halo', Ivory Halo Compact Variegated Shrub Dogwood, 2G	98		
Cornus florida 'Cherokee Princess', Cherokee Princess Flowering Dogwood, 2.5"-3" B/B	3		
Cornus kousa, Korean Dogwood, 2.5"-3" B/B	5		
Deutzia gracilis 'Nikko', Spreading Deutzia, 2G	224		
Dianthus gratianopolitanus 'Firewitch', Fire Witch Cheddar Pinks, 1G	151		
Enkianthus campanulatus, Redvein Enkianthus, 3G	9		
Geranium x 'Rozanne', Rozanne Cranesbill, 1G	16		

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Plant Type, Variety and Size (Continued)	Quantity	Unit Cost	Cost
Ginkgo biloba 'Princeton Sentry', Princeton Sentry Narrow Maiden Hair Tree, 2.5”-3” B/B	3		
Heuchera 'Kassandra', Kassandra Coral Bells, 1G	8		
Ilex glabra 'Compacta',Compact Inkberry, 3G	15		
Ilex x meserveae 'Blue Prince', Male Meservea Hybrid Holly, 5G	40		
Ilex x meserveae 'Blue Princess', Female Meserveae Hybrid Holly, 5G	89		
Juniperus chinensis ‘Daub's Frosted', Daub's Frosted Chinese Juniper, 5G	13		
Juniperus chinensis 'Spartan', Spartan Chinese Juniper, 6’-7’ B/B	14		
Juniperus horizontalis 'Wiltonii', Blue Rug Juniper, 2G	395		
Juniperus squamata ‘Blue Star’, Blue Star Singe Seed Juniper, 2G	47		
Panicum virgatum 'Heavy Metal', Heavy Metal Switch Grass, 3G	5		
Panicum virgatum 'Ruby Ribbons', Ruby Ribbons Switch Grass, 3G	37		
Picea abies, Norway Spruce, 12’-14’ B/B	17		
Picea pungens, Colorado Spruce, 8’-10’ B/B	5		
Picea pungens ‘Glauca Clobosa’, Dwarf Globe Blue Spruce, 6G	4		
Pinus strobus, White Pine, 12’-14 B/B	5		
Prunus serrulata 'Snow Goose', Snow Goose Flowering Cherry, 3”-3.5” B/B	7		
Rhododendron 'PJM Compacta', Compact PJM Small Leaf Rhododendron, 3G	32		
Rosa ‘Home Run Red’, Home Run Red Rose, 3G	17		
Rosa x 'Single Knockout, Single Knockout Rose, 3G	14		
Salvia nemerosa 'Caradonna', Caradonna Meadow Sage, 1G	16		
Sedum 'Autumn Joy', Autumn Joy Stonecrop, 1G	25		
Sedum rupestre 'Angelina', Angelina Stonecrop, 1G	108		
Spiraea x bumalda 'Gold Mound', Gold Mound Spiraea, 2G	38		
Spiraea japonica ‘Alpina’, Alpine Spiraea, 2G	11		
Syringa meyerii 'Paliban', Paliban Dwarf Korean Lilac, 6G	42		
Syringa retiiculata, Japanese Lilac Tree, 2"-2.5" B/B	5		
Thuja occidentalis 'Degroot's Spire', Degroot's Spire American Arborvitae, 5’-6’ B/B	14		
Thuja plicata 'Green Giant', Green Giant Western Arborvitae, 7’-8’ B/B	10		
Thymus pseudolanuginosus, Wooly Thyme, 1QT.	350		
Viburnum plicatum var. tomentosum 'Watanabei', Summer Snowflake Viburnum, 4’-5’ B/B	27		
Weigela florida 'Wine and Roses', Compact Wine and Roses Weigela, 6G	24		
		Total	

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Meriden Station

Plant Type, Variety and Size	Quantity	Unit Cost	Cost
Cornus alba 'Ivory Halo', Ivory Halo Compact Variegated Shrub Dogwood, 2G	91		
Deutzia gracilis 'Nikko', Spreading Deutzia, 2G	163		
Dianthus gratianopolitanus ,'Firewitch', Fire Witch Cheddar Pinks, 1G	70		
Ilex glabra 'Compacta',Compact Inkberry, 3G	35		
Juniperus horizontalis 'Wiltonii', Blue Rug Juniper, 2G	256		
Panicum virgatum 'Cloud Nine', Cloud Nine Switch Grass, 3G	15		
Panicum virgatum 'Heavy Metal', Heavy Metal Switch Grass, 3G	12		
Panicum virgatum 'Ruby Ribbons', Ruby Ribbons Switch Grass, 3G	24		
Prunus cerasifera 'Krauter's Vesuvius', Upright Purple Leaf Plum 2.5”-3” B/B	11		
Prunus serrulata 'Snow Goose', Snow Goose Flowering Cherry, 2.5”-3” B/B	9		
Rosa ‘Home Run Red’, Home Run Red Rose, 3G	18		
Sedum rupestre 'Angelina', Angelina Stonecrop, 1G	100		
Spiraea japonica ‘Alpina’, Alpine Spiraea, 2G	68		
Syringa patula ‘Ms. Kim, Ms. Kim Korean Lilac, 6G	28		
Syringa retiiculata ‘Ivory Silk’, Ivory Silk Japanese Lilac Tree, 2"-2.5" B/B	9		
		Total	

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Berlin Station

Plant Type, Variety and Size	Quantity	Unit Cost	Cost
Acer x freemanii 'Autumn Blaze', Autumn Blaze Maple Hybrid, 3”-3.5” B?B	1		
Astilbe 'Visions in Red', Visions in Red False Spirea, 2G	31		
Coreopsis x 'Full Moon', Full Moon Tickseed, 1G	4		
Cornus alba 'Ivory Halo', Ivory Halo Compact Variegated Shrub Dogwood, 3G	112		
Deutzia gracilis 'Nikko', Spreading Deutzia, 2G	263		
Dianthus gratianopolitanus 'Firewitch', Fire Witch Cheddar Pinks, 1G	88		
Heuchera 'Kassandra', Kassandra Coral Bells, 1G	6		
Ilex glabra 'Compacta',Compact Inkberry, 5G	114		
Juniperus chinensis 'Spartan', Spartan Chinese Juniper, 6’-7’ B/B	26		
Juniperus horizontalis 'Wiltonii', Blue Rug Juniper, 2G	326		
Panicum virgatum 'Cloud Nine’, Cloud Nine Switch Grass, 3G	36		
Panicum virgatum 'Heavy Metal', Heavy Metal Switch Grass, 3G	79		
Panicum virgatum 'Ruby Ribbons', Ruby Ribbons Switch Grass, 3G	76		
Prunus cerasifera 'Krauter's Vesuvius', Upright Purple Leaf Plum 2.5”-3” B/B	10		
Prunus serrulata 'Snow Goose', Snow Goose Flowering Cherry, 2.5”-3” B/B	11		
Pyrus calleryana 'Chanticleer', Cleveland Select Callery Pear, 2.5”-3” B/B	3		
Rhododendron 'PJM Compacta', Compact PJM Small Leaf Rhododendron, 6G	3		
Rosa ‘Home Run Red’, Home Run Red Rose, 3G	35		
Salvia nemerosa 'Caradonna', Caradonna Meadow Sage, 1G	3		
Spiraea japonica ‘Alpina’, Alpine Spiraea, 2G	210		
Syringa meyerii 'Paliban', Paliban Dwarf Korean Lilac, 6G	9		
Syringa retiiculata ‘Ivory Silk’, Ivory Silk Japanese Lilac Tree, 2"-2.5" B/B	8		
Viburnum plicatum var. tomentosum 'Watanabei', Summer Snowflake Viburnum, 3’-4’ B/B	4		
		Total	

9.49.03 – Construction Methods: *Replace Subsection 1 with the following:*

1. Planting Season: The planting season shall be as indicated below. No planting shall be done in frozen ground or when snow covers the ground, or the soil is otherwise in an unsatisfactory condition for planting.

Deciduous Material: Spring, from March 1st to May 1st (inclusive) except for balled and burlapped material, the planting of which will terminate on May 15th.

Evergreen Material: Spring, from March 1st to June 1st (inclusive).

9.49.04 – Method of Measurement: *Replace Subsection 1 with the following:*

1. Plantings: This work is being paid as a Lump Sum and will not be measured for payment.

9.49.05 – Basis of Payment: *Replace Subsection 1 with the following:*

2. Plantings: Partial payment for this work will be made up to 80% of the schedule of values price each for the kind and size of plant and the method of planting, as the case may be, satisfactorily completed in place. Final payment will not be provided until final acceptance of all plantings.

Pay Item	Pay Unit
Furnishing, Planting and Mulching Trees, Shrubs, Vines and Ground Cover Plants	L.S.

ITEM #0949110A - RAIN GARDEN

Description: This item shall consist of the installation of rain garden soil mix, fine grading, seeding, and planting rain garden plants and compost-mulch within rain garden and bioretention swales as shown on the Plans or as ordered by the Engineer.

Materials: Materials for this work shall conform to the following:

1. **Rain Garden Plantings:** Plantings shall conform to the requirements of Section M.13.

2. **Topsoil:** Topsoil shall conform to the requirements of Subarticle M.13.01-1.

3. **High Density Polyethylene Pipe – Perforated (corrugated polyethylene pipe (Type SP)):** High Density Polyethylene Pipe – Perforated (corrugated polyethylene pipe (Type SP)) shall conform to the requirements of Subarticle M.08.01-25.

4. **Geotextile:** Geotextile shall conform to the requirements of Subarticle M.08.01-26.

5. **Crushed Stone:** Crushed stone shall conform to the requirements of Subarticle M.02.06-1, Grading "C".

6. **Rain Garden Soil Mixture:** The rain garden soil mixture shall be a uniform mixture of 50% sand, 30-35% sandy topsoil, a maximum of 0-6% clay, and 20% compost. The pH shall be between 5.2 and 7.0. Other analytes shall not exceed the following: 32 ppm Mg; 69 ppm P as Phosphate; 78 ppm K as K20; and 500 ppm soluble salts. The soil shall be free from stones, stumps, roots or other objects larger than 2" in any direction. The soil mixture shall be free from noxious weeds or invasive species. The Contractor shall provide a report from a soil testing laboratory that compares the soil mix to this specification.

7. **Compost Mulch:** Compost mulch shall be used for mixing into the rain garden soil mix, and as a surface mulch layer in rain garden / biorentention areas. Compost mulch shall be sourced from organic wastes including sawdust, clean ground wood, leaf and vegetative yard residues that meet all State Environmental Agency requirements. The product shall be well composted, free of viable weed seeds and contain material of a generally humus nature capable of sustaining growth of vegetation, with no materials toxic to plant growth. Compost mulch shall have an acidity range of between 4.5 pH and 6.5 pH.

Construction Methods: Construction methods for this work shall conform to the following:

a. All Rain Garden work shall be performed in compliance with the current standards established by the American Association of State Highway and Transportation Officials (AASHTO), the United States Environmental Protection Agency (EPA), the United States Compost Council (USCC), and the Northeast Organic Farming Association (NOFA).

b. Prior to the commencement of the rain garden installation, a field meeting shall be held between, at a minimum, the Contractor, the Engineer, and the Designer to discuss all aspects of the application, including coordination with other concurrent construction activities. This meeting shall also include the field inspection of the landscape beds to receive compost-mulch treatment, to identify any field modifications to the work and to ensure that beds are clear of debris.

c. The rain garden area shall be excavated to the subgrade shown on the Plans, and construction details.

d. Use equipment that will minimize compaction of rain garden subgrades. Vehicle/machinery traffic in the depressed portion of the rain garden shall be avoided to prevent compaction of the underlying soils. If machinery must be used in the rain garden area for grading, the Contractor shall use wide track or marsh track equipment or light equipment with turf type tires. Compaction can be alleviated by using primary tilling operations such as a chisel plow, ripper or subsoiler to a 12" depth.

e. Place soil backfill in lifts not to exceed 12 inches per lift. Do not use heavy equipment within the rain garden footprint. Work from outside the rain garden footprint with an excavator to place the soil.

f. The soil lifts shall be compacted by saturating the entire area of the rain garden until water flows from the underdrain.

g. Use an appropriate sediment control device to treat sediment laden water discharged from the underdrain.

h. If the soil mixture becomes contaminated with unapproved soils during the construction of the rain garden, the contaminated material shall be removed and replaced with uncontaminated material at no cost to the State.

i. Fine grade by hand raking. Final elevations shall be within 2 inches of the elevations shown on the Plans.

j. The Contractor shall apply compost-mulch material in minimum three inch deep blanket uniformly covering the surface of all rain garden / bioretention planting beds. Compost-mulch blanket will typically be hydraulically blown onto and over the surface of previously placed topsoil in a process similar to hydroseeding. Compost-mulch shall be placed within one week following installation of plant material in any given area. Compost-mulch application shall in no way damage installed plants.

k. Immediately following compost mulch application, landscape beds shall be protected by temporary fencing from foot traffic to prevent soil compaction and smothering of root systems until all plantings are fully established. Maintenance vehicular traffic will not be

permitted within the landscape beds, but will be permitted to park on paved surfaces immediately adjacent to landscape beds.

Method of Measurement: This work will be measured for payment by the actual number of square yards of completed and accepted "Rain Garden".

Topsoil within the limits of the rain garden will not be measured for payment, but shall be considered as part of the general cost of the work.

High Density Polyethylene Pipe – Perforated will be measured for payment in accordance with Article 6.51.04.

Geotextile will be measured for payment in accordance with Article 7.55.04.

Crushed stone will be measured for payment in accordance with Article 2.13.04.

Basis of Payment: This work will be paid for at the contract unit price per square yard for "Rain Garden", complete in place, which price shall include all plantings, soil mixture and compost mulch, and all equipment, tools, materials and labor incidental thereto. There will be no separate payment for topsoil within the limits of the rain garden as that work shall be considered part of the general cost of the work.

High Density Polyethylene Pipe – Perforated will be paid for in accordance with Article 6.51.05.

Geotextile will be paid for in accordance with Article 7.55.05

Crushed stone will be paid for in accordance with Article 2.13.05.

Pay Item	Pay Unit
Rain Garden	s.y.

ITEM # 0969000A - PROJECT COORDINATOR

Section 1.05.08 of the Standard Specifications is hereby deleted and replaced with the following:

Description: Under this item the Contractor shall furnish the services of an administrative employee, entitled the Project Coordinator, for this project to coordinate and expedite all phases of the work required for the project and to ensure that the construction schedule is maintained.

The minimum lump sum bid for this item shall be equal to 0.5% of the Contractor's total bid. Failure of the Contractor to bid at least the minimum amount will result in the Department adjusting the Contractor's bid to include the minimum bid amount for this item.

The Project Coordinator shall be submitted for approval by name, in writing, with a resume of his qualifications, within seven (7) calendar days of the award of the Contract, but not later than the Preconstruction Meeting, and shall not be changed without prior written notice to the Department.

This resume must demonstrate the Project Coordinator is experienced and versatile in the preparation, interpretation and modification of Critical Path Method (CPM) construction schedules. This must include successful completion of at least three (3) construction projects of similar complexity, where he served in a lead scheduling capacity. If the Contractor does not have a person in their company that has these skills, then the Contractor shall engage the services of a Consultant, subject to the approval of the Engineer, for the scheduling work required. If a Consultant is engaged, they shall be present at the first meeting, along with the Project Contractor, prepared to discuss, in detail, the methods and techniques he proposes to use. Thereafter, the Project Coordinator or the Consultant responsible for updating the CPM Schedule shall attend all meetings between the Contractor, its Subcontractors, and any other meetings, which will affect the CPM schedule. The Contractor shall prepare CPM Schedules utilizing the latest version of Primavera Project Planner software as described more fully hereinafter.

If the Contract includes Article 1.20 the following requirement shall also apply:

The Project Coordinator shall have, in addition to the above noted requirements, a minimum of eight (8) years' experience related to commercial/industrial building construction as a Project Coordinator performing duties similar to those required herein.

The Project Coordinator shall have knowledge of all trades involved in the construction, including civil/site work, environmental work, concrete work, masonry work, steel work, wood work, electrical work, and mechanical work.

Other combinations of experience and education totaling ten (10) years in commercial building construction will be considered subject to the approval of the Engineer.

Computer Software and Printer: The Contractor shall provide the following equipment with all the required maintenance and repairs (to include labor and parts) throughout the Contract life. The Engineer reserves the right to expand or relax the specification to adapt to the software and hardware limitations and availability.

The Contractor shall provide the Engineer with a licensed copy registered in the Department's name of the latest versions of the software listed and maintain customer support services offered by the software producer for the duration of the project. The Contractor shall deliver to the Engineer all supporting documentation for the software and hardware including any instructions or manuals.

A. Software – Minimum Specification: The Contractor shall provide the Engineer with a licensed copy of the latest version of the Primavera Contractor – Deluxe Version scheduling software, registered in the Department's name, and maintain the Primavera customer support service contract over the duration of the project.

B. HP Officejet Pro K8600 Color Printer – Minimum or equivalent (to be installed as a local printer on a computer provided under the Construction Field Office specification):

Paper – 11 in x17 in, 8.5 in x 11 in and duplex/double-side print
Resolution – 1200x1200 DPI
Print Drivers – Must support HP PCL6.
RAM – 32 MB RAM
Print speed – 10 ppm – color, 13 ppm - black
Printer cable – 6 ft (1.8 m)

The Contractor is responsible for service and repairs to all computer hardware. All repairs must be performed within 24 hours. If the repairs require more than a 24 hours then a replacement must be provided.

Construction Methods: The Project Coordinator shall attend all meetings between the Contractor and the Department, the Contractor and its Subcontractors, and any other meetings that affect the progress of the job. The Project Coordinator shall be knowledgeable of the status of all parts of the work throughout the length of the Contract.

The Contractor shall prepare a CPM Schedule in accordance with the pertinent provisions of "Section 1.03 - Award and Execution of Contract," "Section 1.05 - Control of the Work," and "Section 1.08 - Prosecution of Progress" of the Standard Specifications. The schedule shall incorporate the Sequence of Construction as outlined on the Plans and in the Specifications. All other limiting factors that affect construction shall also be incorporated into the schedule. All milestones or constrained dates within the schedule shall be clearly indicated.

The CPM schedule shall contain a list of activities that represent the major elements of the project. At a minimum, this list should include a breakdown by individual structure or stage, including major components of each. The schedule shall contain sufficient detail to describe the progression of the work in a comprehensive manner. As a guide, 10 to 15 activities should be provided for each $1 million of contract value.

The following list of items is provided as an example only and is not meant to be all-inclusive (or all-applicable):

General Items Applicable to all projects

Contractual Constraints including but not limited to

- Winter shutdowns
- Environmental permits/applications time of year restrictions
- Milestones
- Third Party approvals
- Long lead time items (procurement and fabrication of major elements)
- Adjacent Projects or work by others

Award
Notice to Proceed
Signing (Construction, temporary, permanent by location)
Mobilization
Permits as required
Field Office
Utility Relocations
Submittals/shop drawings/working drawings/product data
Construction of Waste Stock pile area
Clearing and Grubbing
Earthwork (Borrow, earth excavation, rock excavation, etc.)
Traffic control items (including illumination and signalization)
Pavement markings
Drainage (Breakdown into components)
Culverts
Final Plantings (including turf establishment)
Final Cleanup

The following additional guidelines supplement the general guidelines listed above for the specific project types indicated:

A. For platforms, stair towers, walls and other structures, include major components such as:

Temporary Earth Retention Systems
Structure Excavation
Piles/test piles
Temporary Structures
Bearing Pads

Structural Steel (Breakdown by fabrication, delivery, installation, painting etc.)

B. Multiple location projects shall be broken down first by location and then by operation.

C. Facility Projects shall reflect the same breakdown of the project as the schedule of values:

CSI Division 2 – Existing Conditions
CSI Division 3 – Concrete
CSI Division 4 – Masonry
CSI Division 5 – Metals
CSI Division 6 – Wood, Plastic, and Composites
CSI Division 7 – Thermal and Moisture Protection
CSI Division 8 – Openings
CSI Division 9 – Finishes
CSI Division 10 – Specialties
CSI Division 11 – Equipment
CSI Division 12 – Furnishings
CSI Division 13 – Special Construction
CSI Division 14 – Conveying Equipment
CSI Division 21 – Fire Suppression
CSI Division 22 – Plumbing
CSI Division 23 – Heating, Ventilating, and Air Conditioning
CSI Division 26 – Electrical
CSI Division 27 – Communications
CSI Division 28 – Electronic Safety and Security
CSI Division 31 – Earthwork
CSI Division 32 – Exterior Improvements
CSI Division 33 – Utilities

The CPM schedule will be compiled using this list of major activities. It will be the responsibility of the contractor to detail all milestones, environmental permit "window" periods; winter shutdowns etc. and include them on their schedule under the corresponding dates.

Proper relationship between all major activities shall be indicated. Node numbers shall be coded such that the major activities shown on the Critical Path Schedule shall be easily referenced to the Detailed Project Schedule when it is developed. Break down the work covered under each Special Provision, or Division and Section of Article 1.20 of the Standard Specifications, into individual activities required and logically group related activities together within the CPM.

If the Engineer determines that additional detail is necessary, the Contractor shall provide it.

All documents, which require approval by the Department, shall be clearly identified within the schedule. The Department and any outside agency shall be allocated a minimum number of calendar days in accordance with Article 1.20-1.05.02. If Article 1.20 does not apply, then the

Department shall be allocated a minimum of thirty (30) calendar days (exclusive of weekends and holidays) for review and approval of each submittal. Any submittals requiring approval by an outside Agency (ConnDEEP, Coast Guard, Army Corps of Engineers, etc.) shall be allocated a minimum of sixty (60) calendar days. The Department shall not be held responsible for any delay associated with the approval or rejection of any substitution or other revisions proposed by the Contractor.

The schedule shall indicate the logic of the work for the major elements and components of work under the Contract, such as the planned mobilization of plant and equipment, sequences of operations, procurement of materials and equipment, duration of activities, type of relationship, lag time (if any), and such other information as it is necessary to present a clear statement of the intended activities.

The Contractor is responsible to inform its subcontractor(s) and supplier(s) of the project schedule and any relevant updates.

The schedules shall consist of a network technique of planning, scheduling and control, shall be a clear statement of the logical sequence of work to be done, and shall be prepared in such a manner that the Contractor's work sequence shall be optimized between early start and late start restraints. The Contractor shall use the same criteria in a consistent manner throughout the term of the project. If, at any time, the Contractor alters logic, original durations, and descriptions, adds activities or activity codes or in any way modifies the Baseline Schedule, they must notify the Engineer of the change, in writing, presenting in detail the reasons for the change. The Engineer reserves the right to approve or reject any such change.

The critical path of the project must be identified on the CPM schedule. The critical path is the longest-duration path through the network. The significance of the critical path is that the activities that lie on it cannot be delayed without delaying the project. Because of its impact on the entire project, critical path analysis is an important aspect of project planning.

The critical path can be identified by determining the following four parameters for each activity:

- ES - earliest start time: the earliest time at which the activity can start given that its precedent activities must be completed first.
- EF - earliest finish time, equal to the earliest start time for the activity plus the time required to complete the activity.
- LF - latest finish time: the latest time at which the activity can be completed without delaying the project.
- LS - latest start time, equal to the latest finish time minus the time required to complete the activity.

The *float time* for an activity is the time between its earliest and latest start time, or between its earliest and latest finish time. Float is the amount of time that an activity can be delayed past its earliest start or earliest finish without delaying the project. Delays to activities on the critical path through the project network in which no float exists, that is, where ES=LS and EF=LF will delay the project.

Float available in the schedule, at any time shall not be considered for the exclusive use of either the State or the Contractor. During the course of contract execution, any float generated due to the efficiencies of either party is not for the sole use of the party generating the float; rather it is a shared commodity to be reasonably used by either party. Project float will be a resource available to both the State and the Contractor.

Each CPM Schedule submittal shall be in the form of an activity on node diagram (precedence diagramming method) and shall include at a minimum; an Early Start computer sort, a Total Float computer sort, an Activity Number computer sort, a Schedule Diagram in the Time Scaled Logic format and a backup data CD-ROM which includes all Primavera project files. The diagrams shall be on 2' x 3' sheets. Additional, more detailed diagrams for important aspects or phases of the work will be required on large or complex projects.

Activity I.D. numbers shall be keyed to the item numbers assigned on the detailed estimate sheet. The first three digits (four digits for highway illumination, signing, traffic signals and utility work) of the activity I.D. number shall be identical to the first three digits of the item number in the contract. The remaining digits may be used to provide unique, orderly and sequential I.D. numbers for each activity.

Activity codes shall be added to the schedule dictionary at the direction of the Engineer. At a minimum, activity codes for responsibility (prime, subcontractor by name), location of work (bridge #, span #, sta. #, site, building, type of work, etc.) and stage or phase number should be included.

The Project Coordinator shall be required to prepare and submit the following documents:

1. Baseline Submittal Requirements: The Contractor shall be guided by the following requirements when submitting the CPM Schedules for review and approval.

    a. Within ten (10) calendar days after award, the Contractor and their scheduler will attend a meeting to discuss the submittal requirements. Within twenty (20) calendar days after contract award, the Contractor shall prepare and submit for review and approval a detailed CPM Schedule for all work. The review and approval process may take up to 21 calendar days and is more fully described in paragraph (b) of this section.

    The work shall be broken out into sufficient detail such that no activity has a duration greater than twenty (20) days, unless approved by the Engineer. As a guide, 25 to 35 activities should be provided per $1 million of contract work. The Engineer shall be the sole judge as to whether the schedule is sufficiently detailed.

All work shall be shown in sufficient detail such that the Critical Path may be identified and the schedule shall incorporate all contract milestones. Upon approval, this schedule shall be designated the "Baseline".

Failure to submit and gain approval for the "Baseline" may result in the Contractor being found in violation of Article 1.02.02 of the Standard Specifications. All elapsed contract time prior to the approval of the “Baseline”, will be considered to be accurately represented by the actual as-built schedule of that time period. No claims for delays during that period will be allowed.

The approval of a Baseline Schedule shall in no way waive the requirements of the contract nor shall it excuse the Contractor from any obligations under the contract.

In no instance will the Contractor be permitted to commence work on any significant portion of the work for which a Baseline Schedule has not been approved without prior written approval from the Department.

b. The Contractor, represented by the Project Coordinator and/or the Consultant, shall participate with the Engineer in the review and evaluation of each schedule submitted. Any and all revisions made necessary as a result of this review shall be made by the Contractor and a revised schedule submitted within ten (10) calendar days. Any further revisions required thereafter shall also be submitted for approval within (10) calendar days.

2. Monthly Updates: Each month, as of a calendar date mutually acceptable to the Contractor and to the Engineer, the Contractor shall deliver to the Engineer three (3) prints of all required schedule diagrams and tabulations. In addition, the Contractor shall deliver one (1) copy of the project backup data CD-ROM(s), which includes all Primavera project files. The schedule shall be updated to show the work actually accomplished during the preceding months, the actual time consumed for each activity, and the estimated time remaining for any activity which as been started but not completed.

The monthly update shall also include revisions to the CPM schedule necessitated by revisions to the project, which have been directed by the Engineer (including, but not limited to extra work) during the month preceding the update. Similarly, any changes to the schedule due to Contractor influences shall also be included within the schedule.

Any changes or revisions made to the approved Baseline shall be identified in narrative form in a cover letter accompanying the monthly update. The Engineer reserves the right to approve or reject any such changes. The narrative shall also describe in general terms the progress of the work since the last schedule update and shall identify any items of special interest. If the schedule revisions extend the Contract completion date, due to extra or added work or delays beyond the control of the Contractor, the Contractor must submit a

request in writing for an extension of time in accordance with Article 1.08.08. This request should be supported by the schedules submitted previously.

The Contractor shall be responsible to develop mitigation measures for all delays, regardless of responsibility, and to identify all time and cost impacts to the work associated with those mitigation measures.

Except as otherwise authorized by the Engineer, monthly submissions received after the due date are considered late.

The reports required for each monthly update shall include all reports generated for approval of the CPM Schedule for that particular portion of the work. On larger or complex projects, the Engineer may require the schedule data sorted by an activity code to better reflect the progression of the work. Summary barcharts may also be required.

3. Biweekly Schedules: Each week, the Contractor shall be required to produce and submit to the Engineer a biweekly schedule showing all activities planned for the following two week period. This short term schedule may be handwritten; however a two week “look ahead” filter from the CPM Schedule is preferred. The biweekly schedule shall clearly indicate all work planned on a crew basis for the two week period.

4. Recovery Schedules: If, in the opinion of the Engineer, the updated schedule indicates that the Project has fallen behind schedule, or that a revision in sequence of operations may be necessary for any other reason, absent a justifiable time extension, the Contractor shall immediately institute all necessary steps to improve the Project’s progress and shall submit such revised network diagrams, tabulations and operational plans, as may be deemed necessary by the Engineer, to demonstrate the manner in which an acceptable rate of progress will be regained.

   Should the Contractor not demonstrate an ability to regain an acceptable rate of progress, the Engineer shall require the schedule to be resource loaded with the next monthly update. No additional compensation will be allowed for resource loading the schedule.

5. As-Built Schedules: Within thirty (30) days of completion of the project, including all corrective work, the Contractor shall submit an "As-Built Schedule" showing the actual progress of work. The Contractor shall submit three prints of this final CPM Schedule and one project backup data CD-ROM which include all Primavera project files for the Engineer's exclusive use.

   If the contract includes Article 1.20 the following shall also apply:

6. Daily Construction Reports: The Project Coordinator shall assist the Engineer in the preparation of a daily construction report by ensuring that each of the Contractor’s employees and subcontractors working on the Project Site on a given day signs the

Engineer's sign-in sheet for that day; and by keeping and providing to the Engineer its own daily list of employees and subcontractors who worked on the Project Site on that day.

Method of Measurement: Within ten (10) calendar days of the award of the Contract, the Contractor shall submit to the Engineer for approval a breakdown of its lump sum bid price for this item detailing:

1. The development cost to prepare the Baseline Schedule in accordance with these specifications. Development costs shall not exceed 25% of the total cost of the item and shall include costs to furnish and install all specified hardware.

2. The cost to provide the services of the Project Coordinator, including costs to prepare and submit the Monthly Updates; furnish and submit any Recovery Schedules; furnish and submit Two Week Look Ahead Schedules and maintenance of and supplies for the specified hardware noted above. A per month cost will be derived by taking this cost divided by the number of Contract months remaining from the date of acceptance of the Baseline Schedule.

3. The cost of submission and certification of the As-Built Schedule in accordance with these specifications. The submission and certification costs shall be no less than 2% of the total cost of the item.
4. Substantiation showing that the costs submitted are reasonable based on the Contractor's lump sum bid.

Upon approval of the payment schedule by the Engineer, payments for work performed will be made as follows:

1. Upon approval of the "Baseline" Schedule by the Engineer, the lump sum development cost will be certified for payment.

2. Upon receipt of each monthly update of the "Baseline" Schedule, the per month cost for the services of the Project Coordinator will be certified for payment.

3. Upon approval of the As-Built Schedule by the Engineer, the lump sum submission and certification cost will be certified for payment.

Basis of Payment: This service will be paid for at the contract lump sum price for "Project Coordinator" complete, which price shall include the preparation and submission of all schedules, updates, reports and submittals. The lump sum price shall also include the cost of providing a complete, licensed copy of the Primavera software which will remain the property of the Engineer, and all materials, equipment, labor and work incidental of this service.

The lump sum price will be certified for payment as described in "Method of Measurement" subject to the following conditions:

1. Any month where the monthly update of the "Baseline" CPM schedule is submitted late, without authorization from the Engineer, will result in the following actions:

   a. The monthly payment for the Project Coordinator item shall be deferred to the next monthly payment estimate. If any monthly submittal is more than thirty (30) calendar days late, there will be no monthly payment for the services of the Project Coordinator.

   b. The greater of 5% of the monthly payment estimate or $25,000 shall be retained from the monthly payment estimate until such time as the Contractor submits all required reports.

   c. If in the opinion of the Engineer, the contractor is not in compliance with this specification, the Engineer may withhold all project payments.

2. In the event the project extends beyond the original completion date by more than thirty (30) calendar days, and a time extension is granted to the Contractor, the Department may require additional CPM updates which will be paid at the per month cost for the services of the Project Coordinator.

3. If, in the opinion of the Engineer, the contractor is not in compliance with this specification or has failed to submit a "Baseline", monthly update or Recovery Schedule for any portion of the work in accordance with this specification, it shall result in the withholding of all contract payments until the schedule is submitted to, and approved by, the Engineer.

Pay Item	Pay Unit
Project Coordinator	L.S.

ITEM # 0969062A - CONSTRUCTION FIELD OFFICE, MEDIUM

Description: Under the item included in the bid document, adequate weatherproof office quarters will be provided by the Contractor for the duration of the work, and if required, for a maximum of ninety days thereafter for the exclusive use of ConnDOT forces and others who may be engaged to augment ConnDOT forces with relation to the contract. The office quarters shall be located convenient to the work site and installed in accordance with Article 1.08.02, this office shall be separated from any office occupied by the Contractor. Ownership and liability of the office quarters shall remain with the Contractor.

Materials: Materials shall be in like new condition for the purpose intended and shall be approved by the Engineer.

Office Requirements: The Contractor shall furnish the office quarters and equipment as described below.

	Description:
400 SF	Sq. Ft. of floor space with a minimum ceiling height of 7 ft. and shall be partitioned as shown on building floor plan as provided by the Engineer.
2 EA	Minimum number of exterior entrances.
7 EA	Minimum number of parking spaces.

Office layout: The office shall have a minimum square footage as indicated in the table above, and shall be partitioned as shown on building floor plan as provided by the Engineer. The underside of the office shall be fully skirted to the ground.

Lavatory Facilities: The Contractor shall furnish lavatory and toilet facilities at a location convenient to the office quarters for the use of Department personnel and such assistants as they may engage. He shall also supply lavatory and sanitary supplies as required.

Windows and Entrances: The windows shall be of a type that will open and close conveniently, shall be sufficient in number and size to provide adequate light and ventilation, and shall be fitted with locking devices, blinds and screens. The entrances shall be secure, screened, and fitted with a lock for which four keys shall be furnished. All keys to the construction field office shall be furnished to the Department and will be kept in their possession while State personnel are using the office. Any access to the entrance ways shall meet applicable building codes and be slip resistant, with appropriate handrails.

Lighting: The Contractor shall equip the office interior with electric lighting that provides a minimum illumination level of 100 foot-candles at desk level height, and electric outlets for each desk and drafting table. The Contractor shall also provide exterior lighting that provides a minimum illumination level of 2 foot-candles throughout the parking area and for a minimum distance of 10 ft. on each side of the field office.

The Contractor shall provide the following additional equipment, facilities, and/or services at the Field Office on this project to include at least the following to the satisfaction of the Engineer:

Parking Facility: Adequate parking spaces with adequate illumination on a paved surface, with surface drainage if needed. If paved parking does not exist adjacent to the field office, the Contractor shall provide a parking area of sufficient size to accommodate the number of vehicles indicated in the table above. Construction of the parking area and driveway, if necessary, will consist of a minimum of 6 inches of processed aggregate base graded to drain. The base material will be extended to the office entrance.

Field Office Security: Physical Barrier Devices - This shall consist of physical means to prevent entry, such as: 1) All windows shall be barred or security screens installed; 2) All field office doors shall be equipped with dead bolt locks and regular day operated door locks; and 3) Other devices as directed by the Engineer to suit existing conditions.

Electric Service: The field office shall be equipped with an electric service panel to serve the electrical requirements of the field office, including: lighting, general outlets, computer outlets, calculators etc., and meet the following minimum specifications:

A. 120/240 volt, 1 phase, 3 wire.
B. Ampacity necessary to serve all equipment. Service shall be a minimum 100 amp dedicated to the construction field office.
C. The electrical panel shall include a main circuit breaker and branch circuit breakers of the size and quantity required.
D. Additional 120 volt, single phase, 20 amp, isolated ground dedicated power circuit with dual NEMA 5-20 receptacles will be installed at each computer workstation location.
E. Additional 120 volt, single phase, 20 amp, isolated ground dedicated power circuit with dual NEMA 5-20 receptacles will be installed, for use by the Telephone Company.
F. Additional 120-volt circuits and duplex outlets as required meeting National Electric Code requirements.
G. One exterior (outside) wall mounted GFI receptacle, duplex, isolated ground, 120 volt, straight blade.
H. After work is complete and prior to energizing, the State's ConnDOT electrical inspector, must be contacted at 860-594-2240. (Do Not Call Local Town Officials)
I. Prior to field office removal the ConnDOT Data Communications office must be notified to deactivate the communications equipment.

Heating, Ventilation and Air Conditioning (HVAC): The field office shall be equipped with sufficient heating, air conditioning and ventilation equipment to maintain a temperature range of 68^{o}-80^{o} Fahrenheit within the field office.

The Following Furnishings and Equipment Shall Be Provided In The Applicable Field Office Type:

Qty	Description:
3 EA	Office desks (2.5 ft x 5 ft) with drawers, locks, and matching desk chairs that have

Qty	Description:
	pneumatic seat height adjustment and dual wheel casters on the base.
2 EA	Office Chairs.
1 EA	Fire resistant cabinets (legal size/4 drawer), locking.
1 EA	Drafting type tables (3 ft x 6 ft) and supported by wall brackets and legs; and matching drafters stool that have pneumatic seat height adjustment, seat back and dual wheel casters on the base.
2 EA	Personal computer tables (4 ft x 2.5 ft).
1 EA	Hot and cold water dispensing unit and supply of cups and bottled water shall be supplied by the Contractor for the duration of the project.
2 EA	Electronic office type printing calculators capable of addition, subtraction, multiplication and division with memory and a supply of printing paper.
2 EA	Telephone.
1 EA	Telephone answering machine.
1 EA	Plain paper facsimile (FAX) machine capable of transmitting via telephone credit card. All supplies, paper and maintenance shall be provided by the Contractor.
1 EA	Copier/Scanner - dry, plain paper with automatic feeder and reducing capability. All supplies, paper and maintenance shall be provided by the Contractor.
2 EA	Computer systems as specified below under Computer Hardware and Software. All supplies and maintenance shall be provided by the Contractor.
1 EA	Laser printer as specified below under Computer Hardware and Software. All supplies, paper and maintenance shall be provided by the Contractor.
2 EA	Digital Camera as specified below under Computer Hardware and Software. All supplies and maintenance shall be provided by the Contractor.
1 EA	Wastebaskets - 30 gal., including plastic waste bags.
3 EA	Wastebaskets - 5 gal., including plastic waste bags.
2 EA	Electric pencil sharpeners.
* EA	Fire extinguishers - provide and install type and number to meet applicable State and local codes for size of office indicated, including a fire extinguisher suitable for use on a computer terminal fire.
1 EA	Vertical plan racks for 2 sets of 2 ft x 3 ft plans for each rack.
1 EA	Infrared Thermometer, including certified calibration, case, cleaning wipes.
1 EA	Concrete Curing Box as specified below under Concrete Testing Equipment.
1 EA	Concrete Air Meter as specified below under Concrete Testing Equipment.
1 EA	Concrete Slump Cone as specified below under Concrete Testing Equipment.

The furnishings and equipment required herein shall remain the property of the Contractor. Any supplies required to maintain or operate the above listed equipment or furnishings shall be provided by the Contractor for the duration of the project.

Telephone Service: This shall consist of the installation of two (2) telephone lines: one (1) line for phone/voice service and one (1) line dedicated for the facsimile machine. The Contractor shall pay all charges except for out-of-state toll calls made by State personnel.

Data Communications Facility Wiring: Contractor shall install a Category 5e 468B patch panel in a central wiring location and Cat 5e cable from the patch panel to each PC station, terminating in a (category 5e 468B) wall or surface mount data jack. The central wiring location shall also house either the data circuit with appropriate power requirements or a category 5 cable run to the location of the installed data circuit. The central wiring location will be determined by the ConnDOT Data Center staff in coordination with the designated field office personnel as soon as the facility is in place. The ConnDOT Project Engineer will provide the Contractor with a copy of the current PC specifications, approved printer list and data wiring schematic as soon as possible after the contract is awarded.

Contractor to run a CAT 5e LAN cable a minimum length of 25 feet for each computer to LAN switch area leaving an additional 10 feet of cable length on each side with terminated RJ45 connectors. Each run / jack shall be clearly labeled with an identifying Jack Number.

The installation of a data communication circuit between the field office and the ConnDOT Data Communication Center in Newington will be coordinated between the ConnDOT District staff, ConnDOT Office of Information Systems and the local phone company. The ConnDOT District staff will coordinate the installation of the data communication service with ConnDOT PC Support once the field office phone number is issued. The Contractor shall provide the field office telephone number(s) to the ConnDOT Project Engineer as soon as possible to facilitate data line and computer installations.

Computer Hardware and Software:

The ConnDOT Project Engineer will provide the Contractor with a copy of the current PC specifications, approved printer list and data wiring schematic as soon as possible after the contract is awarded.

Before ordering the computer hardware and software, the Contractor must submit a copy of their proposed PC specifications and the type of printer to the ConnDOT Project Engineer for review by the ConnDOT Data Center. If the specification meets or exceeds the minimum specifications listed below, then the Contractor will be notified that the order may be placed.

Before any equipment is delivered to the Data Center, arrangements must be made a minimum of 24 hours in advance by contacting 860-594-3500. All software, hardware and licenses listed below shall be clearly labeled, specifying the (1) Project No., (2) Contractor Name, (3) Project Engineer's Name and (4) Project Engineer's Phone No., and shall be delivered to the ConnDOT Data Center, 2710 Berlin Turnpike, Newington, CT, where it will be configured and prepared for field installation. Installation will then be coordinated with ConnDOT field personnel and the computer system specified will be stationed in the Department's project field office.

The computer system furnished shall have all software and hardware necessary for the complete installation of the latest versions of the software listed, and therefore supplements the minimum specifications below. The Engineer reserves the right to expand or relax the specification to adapt to the software and hardware limitations and availability, the compatibility with current

agency systems, and to provide the Department with a computer system that can handle the needs of the project. This requirement is to ensure that the rapid changing environment that computer systems have experienced does not leave the needs of the project orphan to what has been specified. There will not be any price adjustment due to the change in the minimum system requirements.

The Contractor shall provide the Engineer with a licensed copy registered in the Department's name of the latest versions of the software listed and maintain customer support services offered by each software producer for the duration of the Contract. The Contractor shall deliver to the Engineer all supporting documentation for the software and hardware including any instructions or manuals. The Contractor shall provide original backup media for the software.

The Contractor shall provide the computer system with all required supplies, maintenance and repairs (including labor and parts) throughout the Contract life.

Once the Contract has been completed, the computer will remain the property of the Contractor. Prior to the return of any computer(s) to the Contractor, field personnel will coordinate with the Data Center personnel for the removal of Department owned equipment, software, data, and associated equipment.

A) Computer – Minimum Specification:

Processor – Intel® Core 2 Duo Processor (2.00 GHz, 800 MHz FSB 2MB L2 Cache)
Memory – 2 GB DIMM DDR2 667MHz.
Monitor – 19.0 inch LCD color monitor.
Graphics – Intel Graphics Media Accelerator 3100. or equivalent.
Hard Drive – 160 GB Ultra ATA hard drive (Western Digital, IBM or Seagate).
Floppy Drive – 3.5 inch 1.44MB diskette drive.
Optical Drive – CD-RW/DVD-RW Combo.
Multimedia Package – Integrated Sound Blaster Compatible AC97 Sound and speakers.
Case – Small Form or Mid Tower, capable of vertical or horizontal orientation.
Integrated Network Adapter – comparable to 3COM PCI 10/100 twisted pair Ethernet.
Keyboard – 104+ Keyboard.
Mouse – Optical 2-button mouse with scroll wheel.
Operating System – Windows XP Professional Service Pack 2; Windows Vista Capable.
Application Software – MS Office 2007 Professional Edition.
Additional Software (Latest Releases, including subscription services for the life of the Contract.–

- Norton Anti-Virus and CD/DVD burning software (ROXIO or NERO),
- Adobe Acrobat Standard

Resource or Driver CD/DVD – CD/DVD with all drivers and resource information so that computer can be restored to original prior to shipment back to the contractor.
Uninterrupted power supply – APC Back-UPS 500VA.

Note A1: All hardware components must be installed before delivery. All software documentation and CD-ROMs/DVD for Microsoft Windows XP Professional, Microsoft

Office 2007 Professional Edition, and other software required software must be provided. Computer Brands are limited to Dell, Gateway and HP brands only. No other brands will be accepted. The ConnDOT Project Engineer will provide the Contractor with a copy of the current PC specifications and approved printer list as soon as possible after the contract is awarded.

Note A2: As of June 30, 2008, Microsoft will no longer distribute Windows XP for retail sale, although the date for specific computer manufacturers may be different. Please consult your manufacturer for details. The Department still requires Windows XP on all PCs. Microsoft has stated that any PCs that are purchased with either Windows Vista Business, or Vista Ultimate are automatically entitled to "downgrade rights", which allow the PC to be rolled back to Windows XP. Please consult the specific manufacturer for details on downgrading new PCs to Microsoft Windows XP after June 30, 2008.

B) Laser Printer – Minimum Specification:

Print speed – 20 ppm.
Resolution – 1,200 x 1,200 dpi.
Paper size – Up to 216 mm x 355 mm (8.5 in x 14 in).
RAM – 16 MB.
Print Drivers – Must support HP PCL6 and HP PCL5e.
Printer cable – 1.8 m (6 ft).

Note B1: Laser printer brands are limited to Hewlett-Packard and Savin brands only. The ConnDOT Project Engineer will provide the Contractor with a copy of the current PC specifications and approved printer list as soon as possible after the contract is awarded.

Note B2: It is acceptable to substitute a multi-function all-in-one printer/copier/scanner/fax machine listed on the approved printer list in place of the required laser printer and fax machine.

C) Digital Camera – Minimum Specification:

Optical – 5 mega pixel, with 3x optical zoom.
Memory – 2 GB.
Features – Date/time stamp feature.
Connectivity – USB cable or memory card reader.
Software – Must be compatible with Windows XP and Vista.
Power – Rechargeable battery and charger.

The Contractor is responsible for service and repairs to all computer hardware. All repairs must be performed with-in 48 hours. If the repairs require more than a 48 hours then a replacement must be provided. All supplies, paper and maintenance for the computers, laptops, printers, copiers, and fax machines shall be provided by the Contractor.

Concrete Testing Equipment: If the Contract includes items that require compressive strength cylinders for concrete, in accordance with the Schedule of Minimum Testing Requirements for

Sampling Materials for Test, the Contractor shall provide the following. All testing equipment will remain the property of the Contractor at the completion of the project.

A) Concrete Cylinder Curing Box – meeting the requirements of Section 6.12 of the Standard Specifications.

B) Air Meter – The air meter provided shall be in good working order and will meet the requirements of AASHTO T 152.

C) Slump Cone Mold – Slump cone, base plate, and tamping rod shall be provided in like-new condition and meet the requirements of AASHTO T119, Standard Test Method for Slump of Hydraulic-Cement Concrete.

Insurance Policy: The Contractor shall provide a separate insurance policy, with no deductible, in the minimum amount of twenty thousand dollars ($20,000.00) in order to insure all State-owned data equipment and supplies used in the office against all losses. The Contractor shall be named insured on that policy, and the Department shall be an additional named insured on the policy. These losses shall include, but not be limited to: theft, fire, and physical damage. The Department will be responsible for all maintenance costs of Department owned computer hardware. In the event of loss, the Contractor shall provide replacement equipment in accordance with current Department equipment specifications, within seven days of notice of the loss. If the Contractor is unable to provide the required replacement equipment within seven days, the Department may provide replacement equipment and deduct the cost of the equipment from monies due or which may become due the Contractor under the contract or under any other contract. The Contractor's financial liability under this paragraph shall be limited to the amount of the insurance coverage required by this paragraph. If the cost of equipment replacement required by this paragraph should exceed the required amount of the insurance coverage, the Department will reimburse the Contractor for replacement costs exceeding the amount of the required coverage.

Maintenance: During the occupancy by the Department, the Contractor shall maintain all facilities and furnishings provided under the above requirements, and shall maintain and keep the office quarters clean through the use of weekly professional cleaning to include, but not limited to, washing & waxing floors, cleaning restrooms, removal of trash, etc. Exterior areas shall be mowed and clean of debris. A trash receptacle (dumpster) with weekly pickup (trash removal) shall be provided. Snow removal, sanding and salting of all parking, walkway, and entrance ways areas shall be accomplished during a storm if on a workday during work hours, immediately after a storm and prior to the start of a workday. If snow removal, salting and sanding are not completed by the specified time, the State will provide the service and all costs incurred will be deducted from the next payment estimate.

Method of Measurement: The furnishing and maintenance of the construction field office will be measured for payment by the number of calendar months that the office is in place and in operation, measured to the nearest month.

There will not be any price adjustment due to any change in the minimum computer system requirements.

Basis of Payment: The furnishing and maintenance of the construction field office will be paid at the listed unit price per month for the item "Construction Field Office, Medium", which price shall include all material, equipment, labor, utility services and work incidental thereto.

The cost of providing the parking area, external illumination, trash removal and snow and ice removal shall be included in the monthly unit price bid for the respective item "Construction Field Office, Medium".

The State will be responsible for payment of data communication user fees and for toll calls by State personnel.

Pay Item	Pay Unit
Construction Field Office, Medium	Month

ITEM # 0969066A - CONSTRUCTION FIELD OFFICE, EXTRA-LARGE

Description: Under the item included in the bid document, adequate weatherproof office quarters will be provided by the Contractor for the duration of the work, and if required, for a maximum of ninety days thereafter for the exclusive use of ConnDOT forces and others who may be engaged to augment ConnDOT forces with relation to the contract. The office quarters shall be located convenient to the work site and installed in accordance with Article 1.08.02, this office shall be separated from any office occupied by the Contractor. Ownership and liability of the office quarters shall remain with the Contractor.

Materials: Materials shall be in like new condition for the purpose intended and shall be approved by the Engineer.

Office Requirements: The Contractor shall furnish the office quarters and equipment as described below.

	Description:
2,000 SF	Sq. Ft. of floor space with a minimum ceiling height of 7 ft. and shall be partitioned as shown on building floor plan as provided by the Engineer.
2 EA	Minimum number of exterior entrances.
15 EA	Minimum number of parking spaces.

Office layout: The office shall have a minimum square footage as indicated in the table above, and shall be partitioned as shown on building floor plan as provided by the Engineer. The underside of the office shall be fully skirted to the ground.

Lavatory Facilities: The Contractor shall furnish a minimum of two (2) separate lavatories and toilet facilities ("men" and "women"), in separately enclosed rooms that are properly ventilated and comply with applicable sanitary codes. The Contractor shall provide each lavatory with hot and cold running water and flush-type toilets. He shall also supply lavatory and sanitary supplies as required.

Windows and Entrances: The windows shall be of a type that will open and close conveniently, shall be sufficient in number and size to provide adequate light and ventilation, and shall be fitted with locking devices, blinds and screens. The entrances shall be secure, screened, and fitted with a lock for which four keys shall be furnished. All keys to the construction field office shall be furnished to the Department and will be kept in their possession while State personnel are using the office. Any access to the entrance ways shall meet applicable building codes and be slip resistant, with appropriate handrails.

Lighting: The Contractor shall equip the office interior with electric lighting that provides a minimum illumination level of 100 foot-candles at desk level height, and electric outlets for each desk and drafting table. The Contractor shall also provide exterior lighting that provides a minimum illumination level of 2 foot-candles throughout the parking area and for a minimum distance of 10 ft. on each side of the field office.

The Contractor shall provide the following additional equipment, facilities, and/or services at the Field Office on this project to include at least the following to the satisfaction of the Engineer:

Parking Facility: Adequate parking spaces with adequate illumination on a paved surface, with surface drainage if needed. If paved parking does not exist adjacent to the field office, the Contractor shall provide a parking area of sufficient size to accommodate the number of vehicles indicated in the table above. Construction of the parking area and driveway, if necessary, will consist of a minimum of 6 inches of processed aggregate base graded to drain. The base material will be extended to the office entrance.

Field Office Security: Physical Barrier Devices - This shall consist of physical means to prevent entry, such as: 1) All windows shall be barred or security screens installed; 2) All field office doors shall be equipped with dead bolt locks and regular day operated door locks; and 3) Other devices as directed by the Engineer to suit existing conditions.

Electric Service: The field office shall be equipped with an electric service panel to serve the electrical requirements of the field office, including: lighting, general outlets, computer outlets, calculators etc., and meet the following minimum specifications:

A. 120/240 volt, 1 phase, 3 wire.
B. Ampacity necessary to serve all equipment. Service shall be a minimum 100 amp dedicated to the construction field office.
C. The electrical panel shall include a main circuit breaker and branch circuit breakers of the size and quantity required.
D. Additional 120 volt, single phase, 20 amp, isolated ground dedicated power circuit with dual NEMA 5-20 receptacles will be installed at each computer workstation location.
E. Additional 120 volt, single phase, 20 amp, isolated ground dedicated power circuit with dual NEMA 5-20 receptacles will be installed, for use by the Telephone Company.
F. Additional 120-volt circuits and duplex outlets as required meeting National Electric Code requirements.
G. One exterior (outside) wall mounted GFI receptacle, duplex, isolated ground, 120 volt, straight blade.
H. After work is complete and prior to energizing, the State's ConnDOT electrical inspector, must be contacted at 860-594-2240. (Do Not Call Local Town Officials)
I. Prior to field office removal the ConnDOT Data Communications office must be notified to deactivate the communications equipment.

Heating, Ventilation and Air Conditioning (HVAC): The field office shall be equipped with sufficient heating, air conditioning and ventilation equipment to maintain a temperature range of 68^{o}-80^{o} Fahrenheit within the field office.

The Following Furnishings and Equipment Shall Be Provided In The Applicable Field Office Type:

QTY	Description:

QTY	Description:
8 EA	Office desks (2.5 ft x 5 ft) with drawers, locks, and matching desk chairs that have pneumatic seat height adjustment and dual wheel casters on the base.
1 EA	Standard secretarial type desk and matching desk chair that has pneumatic seat height adjustment and dual wheel casters on the base.
1 EA	Conference table, 3 ft x12 ft.
20 EA	Office Chairs.
3 EA	Fire resistant cabinets (legal size/4 drawer), locking.
4 EA	Non-fire resistant cabinets (legal size/4 drawer), locking.
2 EA	Storage racks to hold 3 ft x 5 ft display charts.
1 EA	Mail slot bin - legal size.
2 EA	Drafting type tables (3 ft x 6 ft) and supported by wall brackets and legs; and matching drafters stool that have pneumatic seat height adjustment, seat back and dual wheel casters on the base.
1 EA	Flat file (4/drawers).
4 EA	Personal computer tables (4 ft x 2.5 ft).
1 EA	Hot and cold water dispensing unit and supply of cups and bottled water shall be supplied by the Contractor for the duration of the project.
4 EA	Electronic office type printing calculators capable of addition, subtraction, multiplication and division with memory and a supply of printing paper.
1 EA	Business telephone system for three lines with ten handsets, intercom capability, and one speaker phone for conference table.
1 EA	Telephone answering machine.
1 EA	Plain paper facsimile (FAX) machine capable of transmitting via telephone credit card. All supplies, paper and maintenance shall be provided by the Contractor.
1 EA	Copier/Scanner - high speed, dry, plain paper with sorting capability, automatic feeder and reducing capability. The copier shall be capable of producing a minimum of 25 copies per minute. All supplies, paper and maintenance shall be provided by the Contractor.
8 EA	Computer systems as specified below under Computer Hardware and Software. All supplies and maintenance shall be provided by the Contractor.
1 EA	Laser printer as specified below under Computer Hardware and Software. All supplies, paper and maintenance shall be provided by the Contractor.
3 EA	Digital Camera as specified below under Computer Hardware and Software. All supplies and maintenance shall be provided by the Contractor.
2 EA	Wastebaskets - 30 gal., including plastic waste bags.
10 EA	Wastebaskets - 5 gal., including plastic waste bags.
2 EA	Electric pencil sharpeners.
2 EA	Electric wall clocks.
* EA	Fire extinguishers - provide and install type and number to meet applicable State and local codes for size of office indicated, including a fire extinguisher suitable for use on a computer terminal fire.
1 EA	Coat rack with 20 coat capacity.
1 EA	Tables - 3 ft x 6 ft.

QTY	Description:
6 EA	Interior partitions - 6 ft x 6 ft, soundproof type, portable and freestanding.
2 EA	Vertical plan racks for 2 sets of 2 ft x 3 ft plans for each rack..
2 EA	Double door supply cabinet with 4 shelves and a lock - 6 ft x 4 ft.
1 EA	Easel/chalkboard.
2 EA	Open bookcases - 3 shelf - 3 ft long.
2 EA	Infrared Thermometer, including certified calibration, case, cleaning wipes.
1 EA	Concrete Curing Box as specified below under Concrete Testing Equipment.
1 EA	Concrete Air Meter as specified below under Concrete Testing Equipment.
1 EA	Concrete Slump Cone as specified below under Concrete Testing Equipment.

The furnishings and equipment required herein shall remain the property of the Contractor. Any supplies required to maintain or operate the above listed equipment or furnishings shall be provided by the Contractor for the duration of the project.

Telephone Service: This shall consist of four (4) telephone lines: three (3) lines for phone/voice service and one (1) line dedicated for the facsimile machine. The Contractor shall pay all charges except for toll calls made by State personnel.

Data Communications Facility Wiring: Contractor shall install a Category 5e 468B patch panel in a central wiring location and Cat 5e cable from the patch panel to each PC station, terminating in a (category 5e 468B) wall or surface mount data jack. The central wiring location shall also house either the data circuit with appropriate power requirements or a category 5 cable run to the location of the installed data circuit. The central wiring location will be determined by the ConnDOT Data Center staff in coordination with the designated field office personnel as soon as the facility is in place. The ConnDOT Project Engineer will provide the Contractor with a copy of the current PC specifications, approved printer list and data wiring schematic as soon as possible after the contract is awarded.

Contractor to run CAT 5e LAN cables from workstations, install patch panel in data circuit demark area and terminate runs with RJ45 jacks at each computer location. Terminate runs to patch panel in LAN switch area. Each cable run / jack shall be clearly labeled with an identifying Jack Number.

The installation of a data communication circuit between the field office and the ConnDOT Data Communication Center in Newington will be coordinated between the ConnDOT District staff, ConnDOT Office of Information Systems and the local phone company. The ConnDOT District staff will coordinate the installation of the data communication service with ConnDOT PC Support once the field office phone number is issued. The Contractor shall provide the field office telephone number(s) to the ConnDOT Project Engineer as soon as possible to facilitate data line and computer installations.

Computer Hardware and Software:

The ConnDOT Project Engineer will provide the Contractor with a copy of the current PC specifications, approved printer list and data wiring schematic as soon as possible after the contract is awarded.

Before ordering the computer hardware and software, the Contractor must submit a copy of their proposed PC specifications and the type of printer to the ConnDOT Project Engineer for review by the ConnDOT Data Center. If the specification meets or exceeds the minimum specifications listed below, then the Contractor will be notified that the order may be placed.

Before any equipment is delivered to the Data Center, arrangements must be made a minimum of 24 hours in advance by contacting 860-594-3500. All software, hardware and licenses listed below shall be clearly labeled, specifying the (1) Project No., (2) Contractor Name, (3) Project Engineer's Name and (4) Project Engineer's Phone No., and shall be delivered to the ConnDOT Data Center, 2710 Berlin Turnpike, Newington, CT, where it will be configured and prepared for field installation. Installation will then be coordinated with ConnDOT field personnel and the computer system specified will be stationed in the Department's project field office.

The computer system furnished shall have all software and hardware necessary for the complete installation of the latest versions of the software listed, and therefore supplements the minimum specifications below. The Engineer reserves the right to expand or relax the specification to adapt to the software and hardware limitations and availability, the compatibility with current agency systems, and to provide the Department with a computer system that can handle the needs of the project. This requirement is to ensure that the rapid changing environment that computer systems have experienced does not leave the needs of the project orphan to what has been specified. There will not be any price adjustment due to the change in the minimum system requirements.

The Contractor shall provide the Engineer with a licensed copy registered in the Department's name of the latest versions of the software listed and maintain customer support services offered by each software producer for the duration of the Contract. The Contractor shall deliver to the Engineer all supporting documentation for the software and hardware including any instructions or manuals. The Contractor shall provide original backup media for the software.

The Contractor shall provide the computer system with all required supplies, maintenance and repairs (including labor and parts) throughout the Contract life.

Once the Contract has been completed, the computer will remain the property of the Contractor. Prior to the return of any computer(s) to the Contractor, field personnel will coordinate with the Data Center personnel for the removal of Department owned equipment, software, data, and associated equipment.

A) <u>Computer – Minimum Specification:</u>

Processor – Intel® Core 2 Duo Processor (2.00 GHz, 800 MHz FSB 2MB L2 Cache)
Memory – 2 GB DIMM DDR2 667MHz.
Monitor – 19.0 inch LCD color monitor.

Graphics – Intel Graphics Media Accelerator 3100. or equivalent.
Hard Drive – 160 GB Ultra ATA hard drive (Western Digital, IBM or Seagate).
Floppy Drive – 3.5 inch 1.44MB diskette drive.
Optical Drive – CD-RW/DVD-RW Combo.
Multimedia Package – Integrated Sound Blaster Compatible AC97 Sound and speakers.
Case – Small Form or Mid Tower, capable of vertical or horizontal orientation.
Integrated Network Adapter – comparable to 3COM PCI 10/100 twisted pair Ethernet.
Keyboard – 104+ Keyboard.
Mouse – Optical 2-button mouse with scroll wheel.
Operating System – Windows XP Professional Service Pack 2; Windows Vista Capable.
Application Software – MS Office 2007 Professional Edition.
Additional Software (Latest Releases, including subscription services for the life of the Contract.–

- Norton Anti-Virus and CD/DVD burning software (ROXIO or NERO),
- Adobe Acrobat Standard

Resource or Driver CD/DVD – CD/DVD with all drivers and resource information so that computer can be restored to original prior to shipment back to the contractor.
Uninterrupted power supply – APC Back-UPS 500VA.

Note A1: All hardware components must be installed before delivery. All software documentation and CD-ROMs/DVD for Microsoft Windows XP Professional, Microsoft Office 2007 Professional Edition, and other software required software must be provided. Computer Brands are limited to Dell, Gateway and HP brands only. No other brands will be accepted. The ConnDOT Project Engineer will provide the Contractor with a copy of the current PC specifications and approved printer list as soon as possible after the contract is awarded.

Note A2: As of June 30, 2008, Microsoft will no longer distribute Windows XP for retail sale, although the date for specific computer manufacturers may be different. Please consult your manufacturer for details. The Department still requires Windows XP on all PCs. Microsoft has stated that any PCs that are purchased with either Windows Vista Business, or Vista Ultimate are automatically entitled to "downgrade rights", which allow the PC to be rolled back to Windows XP. Please consult the specific manufacturer for details on downgrading new PCs to Microsoft Windows XP after June 30, 2008.

B) Laser Printer – Minimum Specification:

Print speed – 20 ppm.
Resolution – 1,200 x 1,200 dpi.
Paper size – Up to 216 mm x 355 mm (8.5 in x 14 in).
RAM – 16 MB.
Print Drivers – Must support HP PCL6 and HP PCL5e.
Printer cable – 1.8 m (6 ft).

Note B1: Laser printer brands are limited to Hewlett-Packard and Savin brands only. The ConnDOT Project Engineer will provide the Contractor with a copy of the current PC specifications and approved printer list as soon as possible after the contract is awarded.

Note B2: It is acceptable to substitute (1) a high-speed multi-function all-in-one printer/copier/scanner/fax machines listed on the approved printer list in place of one required laser printer and fax machine, and (2) a multi-function all-in-one printer/copier/scanner/fax machine listed on the approved printer list in place of the second required laser printer and fax machine. Only one of these devices is required to be set-up to function as the one required fax machine.

C) Digital Camera – Minimum Specification:

Optical – 5 mega pixel, with 3x optical zoom.
Memory – 2 GB.
Features – Date/time stamp feature.
Connectivity – USB cable or memory card reader.
Software – Must be compatible with Windows XP and Vista.
Power – Rechargeable battery and charger.

The Contractor is responsible for service and repairs to all computer hardware. All repairs must be performed with-in 48 hours. If the repairs require more than a 48 hours then a replacement must be provided. All supplies, paper and maintenance for the computers, laptops, printers, copiers, and fax machines shall be provided by the Contractor.

Concrete Testing Equipment: If the Contract includes items that require compressive strength cylinders for concrete, in accordance with the Schedule of Minimum Testing Requirements for Sampling Materials for Test, the Contractor shall provide the following. All testing equipment will remain the property of the Contractor at the completion of the project.

A) Concrete Cylinder Curing Box – meeting the requirements of Section 6.12 of the Standard Specifications.

B) Air Meter – The air meter provided shall be in good working order and will meet the requirements of AASHTO T 152.

C) Slump Cone Mold – Slump cone, base plate, and tamping rod shall be provided in like-new condition and meet the requirements of AASHTO T119, Standard Test Method for Slump of Hydraulic-Cement Concrete.

Insurance Policy: The Contractor shall provide a separate insurance policy, with no deductible, in the minimum amount of forty thousand dollars ($40,000.00) in order to insure all State-owned data equipment and supplies used in the office against all losses. The Contractor shall be named insured on that policy, and the Department shall be an additional named insured on the policy. These losses

shall include, but not be limited to: theft, fire, and physical damage. The Department will be responsible for all maintenance costs of Department owned computer hardware. In the event of loss, the Contractor shall provide replacement equipment in accordance with current Department equipment specifications, within seven days of notice of the loss. If the Contractor is unable to provide the required replacement equipment within seven days, the Department may provide replacement equipment and deduct the cost of the equipment from monies due or which may become due the Contractor under the contract or under any other contract. The Contractor's financial liability under this paragraph shall be limited to the amount of the insurance coverage required by this paragraph. If the cost of equipment replacement required by this paragraph should exceed the required amount of the insurance coverage, the Department will reimburse the Contractor for replacement costs exceeding the amount of the required coverage.

Maintenance: During the occupancy by the Department, the Contractor shall maintain all facilities and furnishings provided under the above requirements, and shall maintain and keep the office quarters clean through the use of weekly professional cleaning to include, but not limited to, washing & waxing floors, cleaning restrooms, removal of trash, etc. Exterior areas shall be mowed and clean of debris. A trash receptacle (dumpster) with weekly pickup (trash removal) shall be provided. Snow removal, sanding and salting of all parking, walkway, and entrance ways areas shall be accomplished during a storm if on a workday during work hours, immediately after a storm and prior to the start of a workday. If snow removal, salting and sanding are not completed by the specified time, the State will provide the service and all costs incurred will be deducted from the next payment estimate.

Method of Measurement: The furnishing and maintenance of the construction field office will be measured for payment by the number of calendar months that the office is in place and in operation, measured to the nearest month.

There will not be any price adjustment due to any change in the minimum computer system requirements.

Basis of Payment: The furnishing and maintenance of the construction field office will be paid at the listed unit price per month for the respective item “Construction Field Office, Extra-Large”, which price shall include all material, equipment, labor, utility services and work incidental thereto.

The cost of providing the parking area, external illumination, trash removal and snow and ice removal shall be included in the monthly unit price bid for the respective item “Construction Field Office, Extra-Large”.

The State will be responsible for payment of data communication user fees and for toll calls by State personnel.

Pay Item	Pay Unit
Construction Field Office, Extra-Large	Month

ITEM #0970006A - TRAFFICPERSON (MUNICIPAL POLICE OFFICER)
ITEM #0970007A - TRAFFICPERSON (UNIFORMED FLAGGER)

9.70.01—Description: Under this item the Contractor shall provide the services of Trafficpersons of the type and number, and for such periods, as the Engineer approves for the control and direction of vehicular traffic and pedestrians. Traffic persons requested solely for the contractor's operational needs will not be approved for payment.

9.70.03—Construction Method: Prior to the start of operations on the project requiring the use of Trafficpersons, a meeting will be held with the Contractor, Trafficperson agency or firm, Engineer, and State Police, if applicable, to review the Trafficperson operations, lines of responsibility, and operating guidelines which will be used on the project. A copy of the municipality's billing rates for Municipal Police Officers and vehicles, if applicable, will be provided to the Engineer prior to start of work.

On a weekly basis, the Contractor shall inform the Engineer of their scheduled operations for the following week and the number of Trafficpersons requested. The Engineer shall review this schedule and approve the type and number of Trafficpersons required. In the event of an unplanned, emergency, or short term operation, the Engineer may approve the temporary use of properly clothed persons for traffic control until such time as an authorized Trafficperson may be obtained. In no case shall this temporary use exceed 8 hours for any particular operation.

If the Contractor changes or cancels any scheduled operations without prior notice of same as required by the agency providing the Trafficpersons, and such that Trafficperson services are no longer required, the Contractor will be responsible for payment at no cost to the Department of any show-up cost for any Trafficperson not used because of the change. Exceptions, as approved by the Engineer, may be granted for adverse weather conditions and unforeseeable causes beyond the control and without the fault or negligence of the Contractor.

Trafficpersons assigned to a work site are to only take direction from the Engineer.

Trafficpersons shall wear a high visibility safety garment that complies with OSHA, MUTCD, ASTM Standards and the safety garment shall have the words "Traffic Control" clearly visible on the front and rear panels (minimum letter size 2 inches (50 millimeters). Worn/faded safety garments that are no longer highly visible shall not be used. The Engineer shall direct the replacement of any worn/faded garment at no cost to the State.

A Trafficperson shall assist in implementing the traffic control specified in the Maintenance and Protection of Traffic contained elsewhere in these specifications or as directed by the Engineer. Any situation requiring a Trafficperson to operate in a manner contrary to the Maintenance and Protection of Traffic specification shall be authorized in writing by the Engineer.

Trafficpersons shall consist of the following types:

1. Uniformed Law Enforcement Personnel: Law enforcement personnel shall wear the high visibility safety garment provided by their law enforcement agency. If no high visibility safety garment is provided, the Contractor shall provide the law enforcement personnel with a garment meeting the requirements stated for the Uniformed Flaggers' garment.

Law Enforcement Personnel may be also be used to conduct motor vehicle enforcement operations in and around work areas as directed and approved by the Engineer.

Municipal Police Officers: Uniformed Municipal Police Officers shall be sworn Municipal Police Officers or Uniformed Constables who perform criminal law enforcement duties from the Municipality in which the project is located. Their services will also include an official Municipal Police vehicle when requested by the Engineer. Uniformed Municipal Police Officers will be used on non-limited access highways. If Uniformed Municipal Police Officers are unavailable, other Trafficpersons may be used when authorized in writing by the Engineer.
Uniformed Municipal Police Officers and requested Municipal Police vehicles will be used at such locations and for such periods as the Engineer deems necessary to control traffic operations and promote increased safety to motorists through the construction sites.

2. Uniformed Flagger: Uniformed Flaggers shall be persons who have successfully completed flagger training by the American Traffic Safety Services Association (ATSSA), National Safety Council (NSC) or other programs approved by the Engineer. A copy of the Flagger's training certificate shall be provided to the Engineer before the Flagger performs any work on the project. Uniformed Flaggers shall conform to Chapter 6E, Flagger Control, in the Manual of Uniformed Traffic Control Devices (MUTCD) and shall wear high-visibility safety apparel, use a STOP/SLOW paddle that is at least 18 inches (450 millimeters) in width with letters at least 6 inches (150 millimeters) high. The paddle shall be mounted on a pole of sufficient length to be 6 feet (1.8 meters) above the ground as measured from the bottom of the sign.

Uniformed Flaggers will only be used on non-limited access highways to control traffic operations when authorized in writing by the Engineer.

9.70.04—Method of Measurement: Services of Trafficpersons will be measured for payment by the actual number of hours for each person rendering services approved by the Engineer. These services shall include, however, only such trafficpersons as are employed within the limits of construction, project right of way of the project or along detours authorized by the Engineer to assist the motoring public through the construction work zone. Services for continued use of a detour or bypass beyond the limitations approved by the Engineer, for movement of construction vehicles and equipment, or at locations where traffic is unnecessarily restricted by the Contractor's method of operation, will not be measured for payment.

Trafficpersons shall not work more than twelve hours in any one 24 hour period. In case such services are required for more than twelve hours, additional Trafficpersons shall be furnished and measured for payment. In cases where the Trafficperson is an employee on the Contractor's payroll, payment under the item "Trafficperson (Uniformed Flagger)" will be made only for those hours when the Contractor's employee is performing Trafficperson services.

Travel time will not be measured for payment for services provided by Uniformed Municipal Police Officers or Uniformed Flaggers.

Mileage fees associated with Trafficperson services will not be measured for payment.

Safety garments and STOP/SLOW paddles will not be measured for payment.

9.70.05—Basis of Payment: Trafficpersons will be paid in accordance with the schedule described herein.
There will be no direct payment for safety garments or STOP/SLOW paddles. All costs associated with furnishing safety garments and STOP/SLOW paddles shall be considered included in the general cost of the item.

1. Uniformed Law Enforcement Personnel: The sum of money shown on the Estimate and in the itemized proposal as "Estimated Cost" for this work will be considered the bid price even though payment will be made as described below. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figures will be disregarded and the original price will be used to determine the total amount for the contract.

The Department will pay the Contractor its actual costs for "Trafficperson (Municipal Police Officer)" plus an additional 5% as reimbursement for the Contractor's administrative expense in connection with the services provided.

The invoice must include a breakdown of each officer's actual hours of work and actual rate applied. Mileage fees associated with Trafficperson services are not reimbursable expenses and are not to be included in the billing invoice. The use of a municipal police vehicle authorized by the Engineer will be paid at the actual rate charged by the municipality. Upon receipt of the invoice from the municipality, the Contractor shall forward a copy to the Engineer. The invoice will be reviewed and approved by the Engineer prior to any payments. *Eighty (80%) of the invoice will be paid upon completion of review and approval. The balance (20%) will be paid upon receipt of cancelled check or receipted invoice, as proof of payment.* The rate charged by the municipality for use of a uniformed municipal police officer and/or a municipal police vehicle shall not be greater than the rate it normally charges others for similar services.

2. Uniformed Flagger: Uniformed flaggers will be paid for at the contract unit price per hour for "Trafficperson (Uniformed Flagger)", which price shall include all compensation, insurance benefits and any other cost or liability incidental to the furnishing of the trafficpersons ordered.

Pay Item	Pay Unit
Trafficperson (Municipal Police Officer)	est.
Trafficperson (Uniformed Flagger)	Hr.

ITEM NO. 971001A – MAINTENANCE AND PROTECTION OF TRAFFIC

Article 9.71.01 – Description is supplemented by the following:

The Contractor shall maintain and protect traffic as follows and as limited in the Special Provision "Prosecution and Progress":

The Contractor shall maintain and protect one lane of through traffic in each direction, each lane on a paved travelpath not less than 11 feet in width.

Excepted therefrom will be those periods, during the allowable periods, when the Contractor is actively working, at which time the Contractor will be allowed to maintain and protect at least an alternating one-way traffic operation on a paved travelpath not less than 12 feet in width. The length of the alternating one-way traffic operation shall not exceed 300 feet.

The Contractor shall maintain access to and egress from all commercial and residential driveways throughout the project limits. The Contractor will be allowed to close said driveways to perform the required work during those periods when the businesses are closed unless permission is granted from the business owner to close the driveway during business hours. If a temporary closure of a residential driveway is necessary, the Contractor shall coordinate with the owner to determine the time period of the closure.

State Street, Meriden, CT

State Street shall be closed to thru traffic by the Contractor to the limits shown on the Construction Staging Plans. The Contractor shall maintain access to and from the closed portion of State Street for his use only and shall maintain and protect traffic from entering this area.

Colony Street, Meriden, CT

The Contractor shall maintain and protect a minimum of one lane of traffic in each direction, each lane on a paved travel path not less than 12 feet in width.

Excepted therefrom will be those periods, during the allowable periods, when the Contractor is actively working, at which time the Contractor shall maintain and protect at least an alternating one-way traffic operation, on a paved travel path not less than 11 feet in width. The length of the alternating one-way traffic operation shall not exceed 300 feet and there shall be no more than one alternating one-way traffic operation within the project limits without prior approval of the Engineer.

North Cherry Street, North Colony Street, and Parker Street, Wallingford, CT

The Contractor shall maintain and protect a minimum of one lane of traffic in each direction, each lane on a paved travel path not less than 11 feet in width.

Excepted therefrom will be those periods, during the allowable periods, when the Contractor is actively working, at which time the Contractor shall maintain and protect at least an alternating one-way traffic operation, on a paved travel path not less than 11 feet in width. The length of the alternating one-way traffic operation shall not exceed 300 feet and there shall be no more than one alternating one-way traffic operation within the project limits without prior approval of the Engineer.

Commercial and Residential Driveways

The Contractor shall maintain access to and egress from all commercial and residential driveways throughout the project limits. The Contractor will be allowed to close said driveways to perform the required work during those periods when the businesses are closed unless permission is granted from the business owner to close the driveway during business hours. If a temporary closure of a residential driveway is necessary, the Contractor shall coordinate with the owner to determine the time period of the closure.

Article 9.71.03 - Construction Method is supplemented as follows:

General

Unpaved travel paths will only be permitted for areas requiring full depth and full width reconstruction, in which case, the Contractor will be allowed to maintain traffic on processed aggregate for a duration not to exceed 10 calendar days. The unpaved section shall be the full width of the road and perpendicular to the travel lanes. Opposing traffic lane dividers shall be used as a centerline.

The Contractor is required to delineate any raised structures within the travel lanes, so that the structures are visible day and night, unless there are specific contract plans and provisions to temporarily lower these structures prior to the completion of work.

The Contractor shall schedule operations so that pavement removal and roadway resurfacing shall be completed full width across a roadway (bridge) section by the end of a workday (work night), or as directed by the Engineer.

When the installation of all intermediate courses of bituminous concrete pavement is completed for the entire roadway, the Contractor shall install the final course of bituminous concrete pavement.

When the Contractor is excavating adjacent to the roadway, the Contractor shall provide a 3-foot shoulder between the work area and travel lanes, with traffic drums spaced every 50 feet. At the end of the workday, if the vertical drop-off exceeds 3 inches, the Contractor shall provide a temporary traversable slope of 4:1 or flatter that is acceptable to the Engineer.

The Contractor, during the course of active construction work on overhead signs and structures, shall close the lanes directly below the work area for the entire length of time overhead work is being undertaken. At no time shall an overhead sign be left partially removed or installed.

If applicable, when an existing sign is removed, it shall be either relocated or replaced by a new sign during the same working day.

The Contractor shall not store any material on-site which would present a safety hazard to motorists or pedestrians (e.g. fixed object or obstruct sight lines).

The field installation of a signing pattern shall constitute interference with existing traffic operations and shall not be allowed, except during the allowable periods.

Construction vehicles entering travel lanes at speeds less than the posted speed are interfering with traffic, and shall not be allowed without a lane closure. The lane closure shall be of sufficient length to allow vehicles to enter or exit the work area at posted speeds, in order to merge with existing traffic.

Signing

The Contractor shall maintain all existing overhead and side-mounted signs throughout the project limits during the duration of the project. The Contractor shall temporarily relocate signs and sign supports as many times as deemed necessary and install temporary sign supports and foundations if necessary and as directed by the Engineer.

Requirements for Winter

The Contractor shall schedule a meeting with representatives from the Department including the offices of Maintenance and Traffic, and the Town/City to determine what interim traffic control measures the Contractor shall accomplish for the winter to provide safety to the motorists and permit adequate snow removal procedures. This meeting shall be held prior to October 31 of each year and will include, but not be limited to, discussion of the status and schedule of the following items: lane and shoulder widths, pavement restoration, traffic signal work, pavement markings, and signing.

Signing Patterns

The Contractor shall erect and maintain all signing patterns per the direction of the Engineer and the traffic control plans contained herein. Proper distances between advance warning signs and proper taper lengths are mandatory.

Pavement Markings – Non-Limited Access Multilane Roadways, Secondary and Local Roadways

During construction, the Contractor shall maintain all pavement markings on paved surfaces on all roadways throughout the limits of the project.

Interim Pavement Markings

The Contractor shall install painted pavement markings, which shall include centerlines, shoulder edge lines, lane lines (broken lines), lane-use arrows, and stop bars, on each intermediate course of bituminous concrete pavement and on any milled surface by the end of the work day/night. If the next course of bituminous concrete pavement will be placed within seven days, shoulder edge lines are not required. The painted pavement markings will be paid under the appropriate items.

If the Contractor will install another course of bituminous concrete pavement within 24 hours, the Contractor may install Temporary Plastic Pavement Marking Tape in place of the painted pavement markings by the end of the work day/night. These temporary pavement markings shall include centerlines, lane lines (broken lines) and stop bars; shoulder edge lines are not required. Centerlines shall consist of two 4 inch wide yellow markings, 2 feet in length, side by side, 4 to 6 inches apart, at 40-foot intervals. No passing zones should be posted with signs in those areas where the final centerlines have not been established on two-way roadways. Stop bars may consist of two 6 inch wide white markings or three 4 inch wide white markings placed side by side. The Contractor shall remove and dispose of the Temporary Plastic Pavement Marking Tape when another course of bituminous concrete pavement is installed. The cost of furnishing, installing and removing the Temporary Plastic Pavement Marking Tape shall be at the Contractor's expense.

If an intermediate course of bituminous concrete pavement will be exposed throughout the winter, then Epoxy Resin Pavement Markings should be installed unless directed otherwise by the Engineer.

Final Pavement Markings

The Contractor should install painted pavement markings on the final course of bituminous concrete pavement by the end of the work day/night. If the painted pavement markings are not installed by the end of the work day/night, then Temporary Plastic Pavement Marking Tape shall be installed as described above and the painted pavement markings shall be installed by the end of the work day/night on Friday of that week.

If Temporary Plastic Pavement Marking Tape is installed, the Contractor shall remove and dispose of these markings when the painted pavement markings are installed. The cost of furnishing, installing and removing the Temporary Plastic Pavement Marking Tape shall be at the Contractor's expense.

The Contractor shall install permanent Epoxy Resin Pavement Markings in accordance with Section 12.10 entitled “Epoxy Resin Pavement Markings, Symbols, and Legends” after such time as determined by the Engineer.

TRAFFIC CONTROL DURING CONSTRUCTION OPERATIONS

The following guidelines shall assist field personnel in determining when and what type of traffic control patterns to use for various situations. These guidelines shall provide for the safe and efficient movement of traffic through work zones and enhance the safety of work forces in the work area.

TRAFFIC CONTROL PATTERNS

Traffic control patterns shall be used when a work operation requires that all or part of any vehicle or work area protrudes onto any part of a travel lane or shoulder. For each situation, the installation of traffic control devices shall be based on the following:

Speed and volume of traffic
Duration of operation
Exposure to hazards

Traffic control patterns shall be uniform, neat and orderly so as to command respect from the motorist.

In the case of a horizontal or vertical sight restriction in advance of the work area, the traffic control pattern shall be extended to provide adequate sight distance for approaching traffic.

If a lane reduction taper is required to shift traffic, the entire length of the taper should be installed on a tangent section of roadway so that the entire taper area can be seen by the motorist.

Any existing signs that are in conflict with the traffic control patterns shall be removed, covered, or turned so that they are not readable by oncoming traffic.

When installing a traffic control pattern, a Buffer Area should be provided and this area shall be free of equipment, workers, materials and parked vehicles.

Typical traffic control plans 19 through 25 may be used for moving operations such as line striping, pot hole patching, mowing, or sweeping when it is necessary for equipment to occupy a travel lane.

Traffic control patterns will not be required when vehicles are on an emergency patrol type activity or when a short duration stop is made and the equipment can be contained within the shoulder. Flashing lights and appropriate trafficperson shall be used when required.

Although each situation must be dealt with individually, conformity with the typical traffic control plans contained herein is required. In a situation not adequately covered by the typical traffic control plans, the Contractor must contact the Engineer for assistance prior to setting up a traffic control pattern.

Placement of Signs

Signs must be placed in such a position to allow motorists the opportunity to reduce their speed prior to the work area. Signs shall be installed on the same side of the roadway as the work area. On multi-lane divided highways, advance warning signs shall be installed on both sides of the highway. On directional roadways (on-ramps, off-ramps, one-way roads), where the sight distance to signs is restricted, these signs should be installed on both sides of the roadway.

Allowable Adjustment of Signs and Devices Shown on the Traffic Control Plans

The traffic control plans contained herein show the location and spacing of signs and devices under ideal conditions. Signs and devices should be installed as shown on these plans whenever possible.

The proper application of the traffic control plans and installation of traffic control devices depends on actual field conditions.

Adjustments to the traffic control plans shall be made only at the direction of the Engineer to improve the visibility of the signs and devices and to better control traffic operations. Adjustments to the traffic control plans shall be based on safety of work forces and motorists, abutting property requirements, driveways, side roads, and the vertical and horizontal curvature of the roadway.

The Engineer may require that the traffic control pattern be located significantly in advance of the work area to provide better sight line to the signing and safer traffic operations through the work zone.

Table I indicates the minimum taper length required for a lane closure based on the posted speed limit of the roadway. These taper lengths shall only be used when the recommended taper lengths shown on the traffic control plans cannot be achieved.

TABLE I – MINIMUM TAPER LENGTHS

POSTED SPEED LIMIT MILES PER HOUR	MINIMUM TAPER LENGTH IN FEET FOR A SINGLE LANE CLOSURE
30 OR LESS	180
35	250
40	320
45	540
50	600
55	660
65	780

Section 1 – Work Zone Safety Meetings

1.a) Prior to the commencement of work, a work zone safety meeting will be conducted with representatives of DOT Construction, Connecticut State Police (Local Barracks), Municipal Police, the Contractor (Project Superintendent) and the Traffic Control Subcontractor (if different than the prime Contractor) to review the traffic operations, lines of responsibility, and operating guidelines which will be used on the project. Other work zone safety meetings during the course of the project should be scheduled as needed.

1.b) A Work Zone Safety Meeting Agenda shall be developed and used at the meeting to outline the anticipated traffic control issues during the construction of this project. Any issues that can't be resolved at these meetings will be brought to the attention of the District Engineer and the Office of Construction. The agenda should include:

- Review Project scope of work and time
- Review Section 1.08, Prosecution and Progress
- Review Section 9.70, Trafficpersons
- Review Section 9.71, Maintenance and Protection of Traffic
- Review Contractor's schedule and method of operations.
- Review areas of special concern: ramps, turning roadways, medians, lane drops, etc.
- Open discussion of work zone questions and issues
- Discussion of review and approval process for changes in contract requirements as they relate to work zone areas

Section 2 – General

2.a) If the required minimum number of signs and equipment (i.e. one High Mounted Internally Illuminated Flashing Arrow for each lane closed, two TMAs, Changeable Message Sign, etc.) are not available; the traffic control pattern shall not be installed.

2.b) The Contractor shall have back-up equipment (TMAs, High Mounted Internally Illuminated Flashing Arrow, Changeable Message Sign, construction signs, cones/drums, etc.) available at all times in case of mechanical failures, etc. The only exception to this is in the case of sudden equipment breakdowns in which the pattern may be installed but the Contractor must provide replacement equipment within 24 hours.

2.c) Failure of the Contractor to have the required minimum number of signs, personnel and equipment, which results in the pattern not being installed, shall not be a reason for a time extension or claim for loss time.

2.d) In cases of legitimate differences of opinion between the Contractor and the Inspection staff, the Inspection staff shall err on the side of safety. The matter shall be brought to the District Office for resolution immediately or, in the case of work after regular business hours, on the next business day.

Section 3 – Installing and Removing Traffic Control Patterns

3.a) Lane Closures shall be installed beginning with the advanced warning signs and proceeding forward toward the work area.

3.b) Lane Closures shall be removed in the reverse order, beginning at the work area, or end of the traffic control pattern, and proceeding back toward the advanced warning signs.

3.c) Stopping traffic may be allowed:

- As per the contract for such activities as blasting, steel erection, etc.
- During paving, milling operations, etc. where, in the middle of the operation, it is necessary to flip the pattern to complete the operation on the other half of the roadway and traffic should not travel across the longitudinal joint or difference in roadway elevation.
- To move slow moving equipment across live traffic lanes into the work area.

3.d) Under certain situations when the safety of the traveling public and/or that of the workers may be compromised due to conditions such as traffic volume, speed, roadside obstructions, or sight line deficiencies, as determined by the Engineer and/or State Police, traffic may be briefly impeded while installing and/or removing the advanced warning signs and the first ten traffic cones/drums only. Appropriate measures shall be taken to safely slow traffic. If required, traffic slowing techniques may be used and shall include the use of Truck Mounted Impact Attenuators (TMAs) as appropriate, for a minimum of one mile in advance of the pattern starting point. Once the advanced warning signs and the first ten traffic cones/drums are installed/removed, the TMAs and sign crew shall continue to install/remove the pattern as described in Section 4c and traffic shall be allowed to resume their normal travel.

3.e) The Contractor must adhere to using the proper signs, placing the signs correctly, and ensuring the proper spacing of signs.

3.f) Additional devices are required on entrance ramps, exit ramps, and intersecting roads to warn and/or move traffic into the proper travelpath prior to merging/exiting with/from the main line traffic. This shall be completed before installing the mainline pattern past the ramp or intersecting roadway.

3.g) Prior to installing a pattern, any conflicting existing signs shall be covered with an opaque material. Once the pattern is removed, the existing signs shall be uncovered.

3.h) On limited access roadways, workers are prohibited from crossing the travel lanes to install and remove signs or other devices on the opposite side of the roadway. Any signs or devices on the opposite side of the roadway shall be installed and removed separately.

Section 4 – Use of High Mounted Internally Illuminated Flashing Arrow

4.a) On limited access roadways, one Flashing Arrow shall be used for each lane that is closed. The Flashing Arrow shall be installed concurrently with the installation of the traffic control pattern and its placement shall be as shown on the traffic control plan. For multiple lane closures, one Flashing Arrow is required for each lane closed. If conditions warrant, additional Flashing Arrows should be employed (i.e.: curves, major ramps, etc.).

4.b) On non-limited access roadways, the use of a Flashing Arrow for lane closures is optional. The roadway geometry, sight line distance, and traffic volume should be considered in the decision to use the Flashing Arrow.

4.c) The Flashing Arrow shall not be used on two lane, two-way roadways for temporary alternating one-way traffic operations.

4.d) The Flashing Arrow board display shall be in the "arrow" mode for lane closure tapers and in the "caution" mode (four corners) for shoulder work, blocking the shoulder, or roadside work near the shoulder. The Flashing Arrow shall be in the "caution" mode when it is positioned in the closed lane.

4.e) The Flashing Arrow shall not be used on a multi-lane roadway to laterally shift all lanes of traffic, because unnecessary lane changing may result.

Section 5 – Use of Truck Mounted Impact Attenuator Vehicles (TMAs)

5.a) For lane closures on limited access roadways, a minimum of two TMAs shall be used to install and remove traffic control patterns. If two TMAs are not available, the pattern shall not be installed.

5.b) On non-limited access roadways, the use of TMAs to install and remove patterns closing a lane(s) is optional. The roadway geometry, sight line distance, and traffic volume should be considered in the decision to utilize the TMAs.

5.c) Generally, to establish the advance and transition signing, one TMA shall be placed on the shoulder and the second TMA shall be approximately 1,000 feet ahead blocking the lane. The flashing arrow board mounted on the TMA should be in the "flashing arrow" mode when taking the lane. The sign truck and workers should be immediately ahead of the second TMA. In no case shall the TMA be used as the sign truck or a work truck. Once the transition is in place, the TMAs shall travel in the closed lane until all Changeable Message Signs, signs, Flashing Arrows, and cones/drums are installed. The flashing arrow board mounted on the TMA should be in the "caution" mode when traveling in the closed lane.

5.d) A TMA shall be placed prior to the first work area in the pattern. If there are multiple work areas within the same pattern, then additional TMAs shall be positioned at each additional work area as needed. The flashing arrow board mounted on the TMA should be in the "caution" mode when in the closed lane.

5.e) TMAs shall be positioned a sufficient distance prior to the workers or equipment being protected to allow for appropriate vehicle roll-ahead in the event that the TMA is hit, but not so far that an errant vehicle could travel around the TMA and into the work area. For additional placement and use details, refer to the specification entitled "Type 'D' Portable Impact Attenuation System". Some operations, such as paving and concrete repairs, do not allow for placement of the TMA(s) within the specified distances. In these situations, the TMA(s) should be placed at the beginning of the work area and shall be advanced as the paving or concrete operations proceed.

5.f) TMAs should be paid in accordance with how the unit is utilized. When it is used as a TMA and is in the proper location as specified, and then it should be paid at the specified hourly rate for "Type 'D' Portable Impact Attenuation System". When the TMA is used as a Flashing Arrow, it should be paid at the daily rate for "High Mounted Internally Illuminated Flashing Arrow". If a TMA is used to install and remove a pattern and then is used as a Flashing Arrow, the unit should be paid as a "Type 'D' Portable Impact Attenuation System" for the hours used to install and remove the pattern, typically 2 hours (1 hour to install and 1 hour to remove), and is also paid for the day as a "High Mounted Internally Illuminated Flashing Arrow".

Section 6 – Use of Traffic Drums and Traffic Cones

6.a) Traffic drums shall be used for taper channelization on limited-access roadways, ramps, and turning roadways and to delineate raised catch basins and other hazards.

6.b) Traffic drums shall be used in place of traffic cones in traffic control patterns that are in effect for more than a 36-hour duration.

6.c) Traffic Cones less than 42 inches in height shall not be used on limited-access roadways or on non-limited access roadways with a posted speed limit of 45 mph and above.

6.d) Typical spacing of traffic drums and/or cones shown on the Traffic Control Plans in the Contract are maximum spacings and may be reduced to meet actual field conditions as required.

Section 7 – Use of (Remote Controlled) Changeable Message Signs (CMS)

7.a) For lane closures on limited access roadways, one CMS shall be used in advance of the traffic control pattern. Prior to installing the pattern, the CMS shall be installed and in operation, displaying the appropriate lane closure information (i.e.: Left Lane Closed - Merge Right). The CMS shall be positioned ½ - 1 mile ahead of the lane closure taper. If

the nearest Exit ramp is greater than the specified ½ - 1 mile distance, than an additional CMS shall be positioned a sufficient distance ahead of the Exit ramp to alert motorists to the work and therefore offer them an opportunity to take the exit.

7.b) CMS should not be installed within 1000 feet of an existing CMS.

7.c) On non-limited access roadways, the use of CMS for lane closures is optional. The roadway geometry, sight line distance, and traffic volume should be considered in the decision to use the CMS.

7.d) The advance CMS is typically placed off the right shoulder, 5 feet from the edge of pavement. In areas where the CMS cannot be placed beyond the edge of pavement, it may be placed on the paved shoulder with a minimum of five (5) traffic drums placed in a taper in front of it to delineate its position. The advance CMS shall be adequately protected if it is used for a continuous duration of 36 hours or more.

7.e) When the CMS are no longer required, they should be removed from the clear zone and have the display screen cleared and turned 90° away from the roadway.

7.f) The CMS generally should not be used for generic messages (ex: Road Work Ahead, Bump Ahead, Gravel Road, etc.).

7.g) The CMS should be used for specific situations that need to command the motorist's attention which cannot be conveyed with standard construction signs (Examples include: Exit 34 Closed Sat/Sun - Use Exit 35, All Lanes Closed - Use Shoulder, Workers on Road - Slow Down).

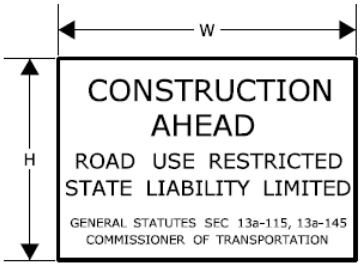
7.h) Messages that need to be displayed for long periods of time, such as during stage construction, should be displayed with construction signs. For special signs, please coordinate with the Office of Construction and the Division of Traffic Engineering for the proper layout/dimensions required.

7.i) The messages that are allowed on the CMS are as follows:

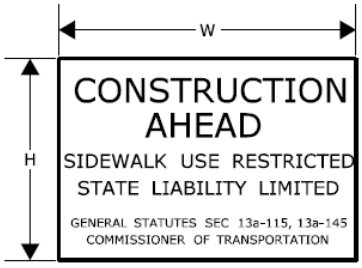
Message No.	Frame 1	Frame 2	Message No.	Frame 1	Frame 2
1	LEFT LANE CLOSED	MERGE RIGHT	9	LANES CLOSED AHEAD	REDUCE SPEED
2	2 LEFT LANES CLOSED	MERGE RIGHT	10	LANES CLOSED AHEAD	USE CAUTION
3	LEFT LANE CLOSED	REDUCE SPEED	11	WORKERS ON ROAD	REDUCE SPEED
4	2 LEFT LANES CLOSED	REDUCE SPEED	12	WORKERS ON ROAD	SLOW DOWN
5	RIGHT LANE CLOSED	MERGE LEFT	13	EXIT XX CLOSED	USE EXIT YY
6	2 RIGHT LANES CLOSED	MERGE LEFT	14	EXIT XX CLOSED USE YY	FOLLOW DETOUR
7	RIGHT LANE CLOSED	REDUCE SPEED	15	2 LANES SHIFT AHEAD	USE CAUTION
8	2 RIGHT LANES CLOSED	REDUCE SPEED	16	3 LANES SHIFT AHEAD	USE CAUTION

For any other message(s), approval must be received from the Office of Construction prior to their use. No more than two (2) displays shall be used within any message cycle.

SERIES 16 SIGNS



		W H
16-E	80-1605	84" x 60"
16-H	80-1608	60" x 42"
16-M	80-1613	30" x 24"



		W H
16-S	80-1619	48" x 30"

THE 16-S SIGN SHALL BE USED ON ALL PROJECTS THAT REQUIRE SIDEWALK RECONSTRUCTION OR RESTRICT PEDESTRIAN TRAVEL ON AN EXISTING SIDEWALK.

SERIES 16 SIGNS SHALL BE INSTALLED IN ADVANCE OF THE TRAFFIC CONTROL PATTERNS TO ALLOW MOTORISTS THE OPPORTUNITY TO AVOID A WORK ZONE. SERIES 16 SIGNS SHALL BE INSTALLED ON ANY MAJOR INTERSECTING ROADWAYS THAT APPROACH THE WORK ZONE. ON LIMITED-ACCESS HIGHWAYS, THESE SIGNS SHALL BE LOCATED IN ADVANCE OF THE NEAREST UPSTREAM EXIT RAMP AND ON ANY ENTRANCE RAMPS PRIOR TO OR WITHIN THE WORK ZONE LIMITS.

THE LOCATION OF SERIES 16 SIGNS CAN BE FOUND ELSEWHERE IN THE PLANS OR INSTALLED AS DIRECTED BY THE ENGINEER.

SIGNS 16-E AND 16-H SHALL BE POST-MOUNTED.

SIGN 16-E SHALL BE USED ON ALL EXPRESSWAYS.

SIGN 16-H SHALL BE USED ON ALL RAMPS, OTHER STATE ROADWAYS, AND MAJOR TOWN/CITY ROADWAYS.

SIGN 16-M SHALL BE USED ON OTHER TOWN ROADWAYS.

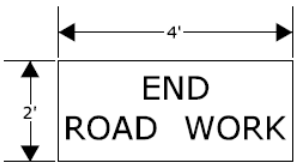
REGULATORY SIGN "ROAD WORK AHEAD, FINES DOUBLED"

THE REGULATORY SIGN "ROAD WORK AHEAD FINES DOUBLED" SHALL BE INSTALLED FOR ALL WORK ZONES THAT OCCUR ON ANY STATE HIGHWAY IN CONNECTICUT WHERE THERE ARE WORKERS ON THE HIGHWAY OR WHEN THERE IS OTHER THAN EXISTING TRAFFIC OPERATIONS.

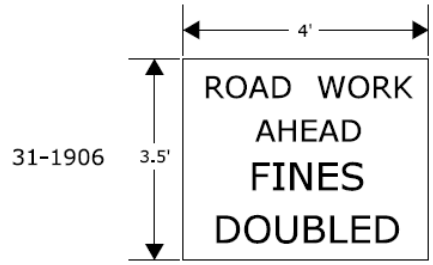
THE "ROAD WORK AHEAD FINES DOUBLED" REGULATORY SIGN SHALL BE PLACED AFTER THE SERIES 16 SIGN AND IN ADVANCE OF THE "ROAD WORK AHEAD" SIGN.

"END ROAD WORK" SIGN

THE LAST SIGN IN THE PATTERN MUST BE THE "END ROAD WORK" SIGN.



80-9612



31-1906

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN
REQUIRED SIGNS

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED

Charles S. Harlow
2012.06.05 11:35:43-04'00'

PRINCIPAL ENGINEER

NOTES FOR TRAFFIC CONTROL PLANS

1. IF A TRAFFIC STOPPAGE OCCURS IN ADVANCE OF SIGN (A), THEN AN ADDITIONAL SIGN (A) SHALL BE INSTALLED IN ADVANCE OF THE STOPPAGE.

2. SIGNS (AA), (A), AND (D) SHOULD BE OMITTED WHEN THESE SIGNS HAVE ALREADY BEEN INSTALLED TO DESIGNATE A LARGER WORK ZONE THAN THE WORK ZONE THAT IS ENCOMPASSED ON THIS PLAN.

3. SEE TABLE 1 FOR ADJUSTMENT OF TAPERS IF NECESSARY.

4. IF THIS PLAN REMAINS IN CONTINUOUS OPERATION FOR MORE THAN 36 HOURS, THEN TRAFFIC DRUMS SHALL BE USED IN PLACE OF TRAFFIC CONES.

5. ANY LEGAL SPEED LIMIT SIGNS WITHIN THE LIMITS OF A ROADWAY / LANE CLOSURE AREA SHALL BE COVERED WITH AN OPAQUE MATERIAL WHILE THE CLOSURE IS IN EFFECT, AND UNCOVERED WHEN THE ROADWAY / LANE CLOSURE IS RE-OPENED TO ALL LANES OF TRAFFIC.

6. IF THIS PLAN REMAINS IN CONTINUOUS OPERATION FOR MORE THAN 36 HOURS, THEN ANY EXISTING CONFLICTING PAVEMENT MARKINGS SHALL BE ERADICATED OR COVERED, AND TEMPORARY PAVEMENT MARKINGS THAT DELINEATE THE PROPER TRAVELPATHS SHALL BE INSTALLED.

7. DISTANCES BETWEEN SIGNS IN THE ADVANCE WARNING AREA MAY BE REDUCED TO 100' ON LOW-SPEED URBAN ROADS (SPEED LIMIT < 40 MPH).

8. IF THIS PLAN IS TO REMAIN IN OPERATION DURING THE HOURS OF DARKNESS, INSTALL BARRICADE WARNING LIGHTS - HIGH INTENSITY ON ALL POST-MOUNTED DIAMOND SIGNS IN THE ADVANCE WARNING AREA.

9. A CHANGEABLE MESSAGE SIGN SHALL BE INSTALLED ONE HALF TO ONE MILE IN ADVANCE OF THE LANE CLOSURE TAPER.

10 SIGN (P) SHALL BE MOUNTED A MINIMUM OF 7 FEET FROM THE PAVEMENT SURFACE TO THE BOTTOM OF THE SIGN.

TABLE 1 - MINIMUM TAPER LENGTHS

POSTED SPEED LIMIT (MILES PER HOUR)	MINIMUM TAPER LENGTH FOR A SINGLE LANE CLOSURE
30 OR LESS	180' (55m)
35	250' (75m)
40	320' (100m)
45	540' (165m)
50	600' (180m)
55	660' (200m)
65	780' (240m)

METRIC CONVERSION CHART (1" = 25mm)

ENGLISH	METRIC	ENGLISH	METRIC	ENGLISH	METRIC
12"	300mm	42"	1050mm	72"	1800mm
18"	450mm	48"	1200mm	78"	1950mm
24"	600mm	54"	1350mm	84"	2100mm
30"	750mm	60"	1500mm	90"	2250mm
36"	900mm	66"	1650mm	96"	2400mm

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

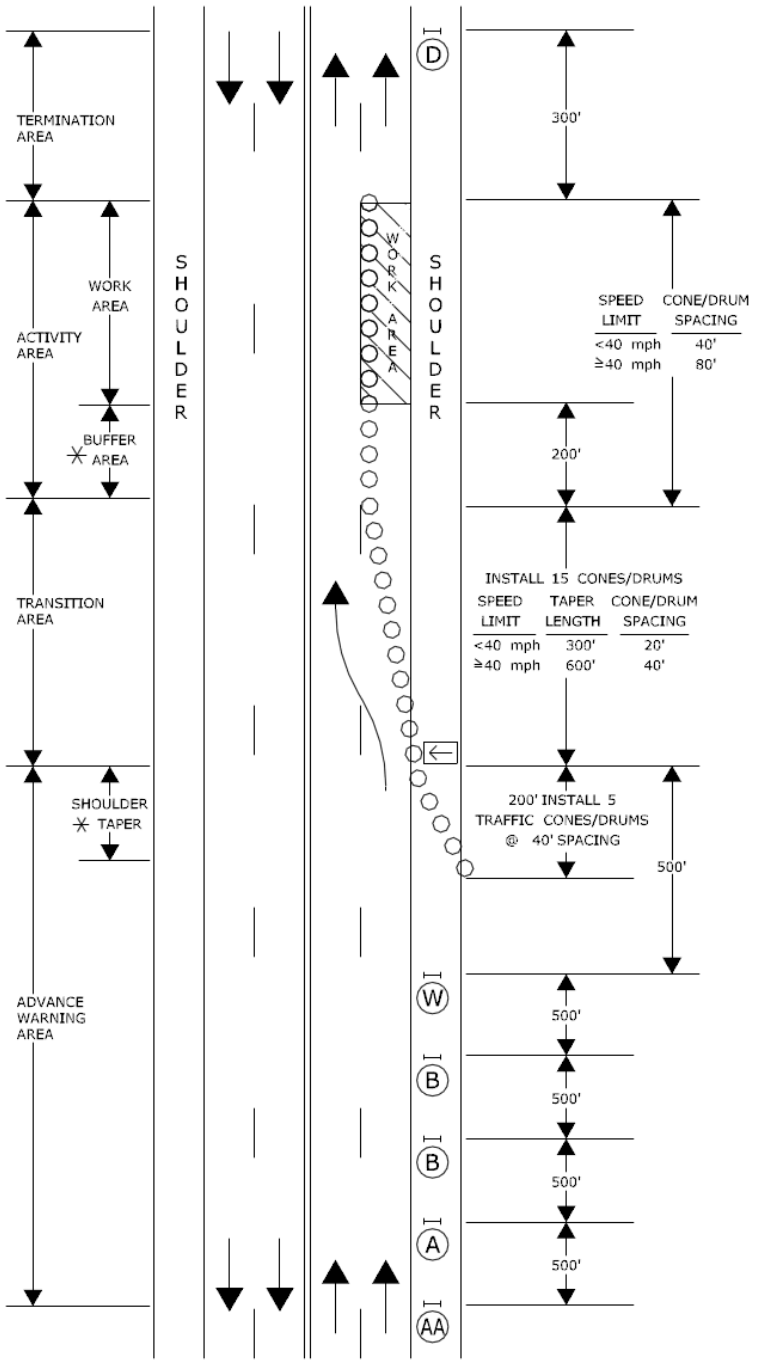
NOTES

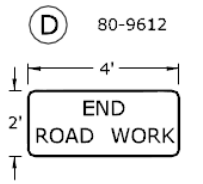
CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

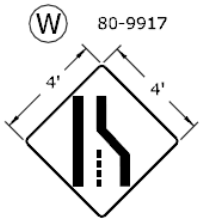
APPROVED Charles S. Harlow 2012.06.05 15:50:35-04'00'
PRINCIPAL ENGINEER

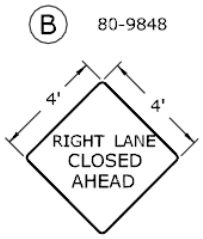
WORK IN RIGHT LANE - 4 LANE UNDIVIDED HIGHWAY

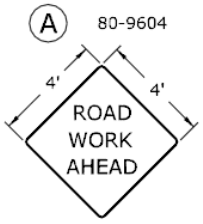
SIGN FACE
86 SQ. FT (MIN.)

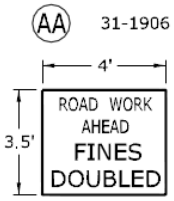












TRAFFIC CONE **OR** TRAFFIC DRUM
OPTIONAL TRAFFIC DRUM PORTABLE SIGN SUPPORT
HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

PLAN 10

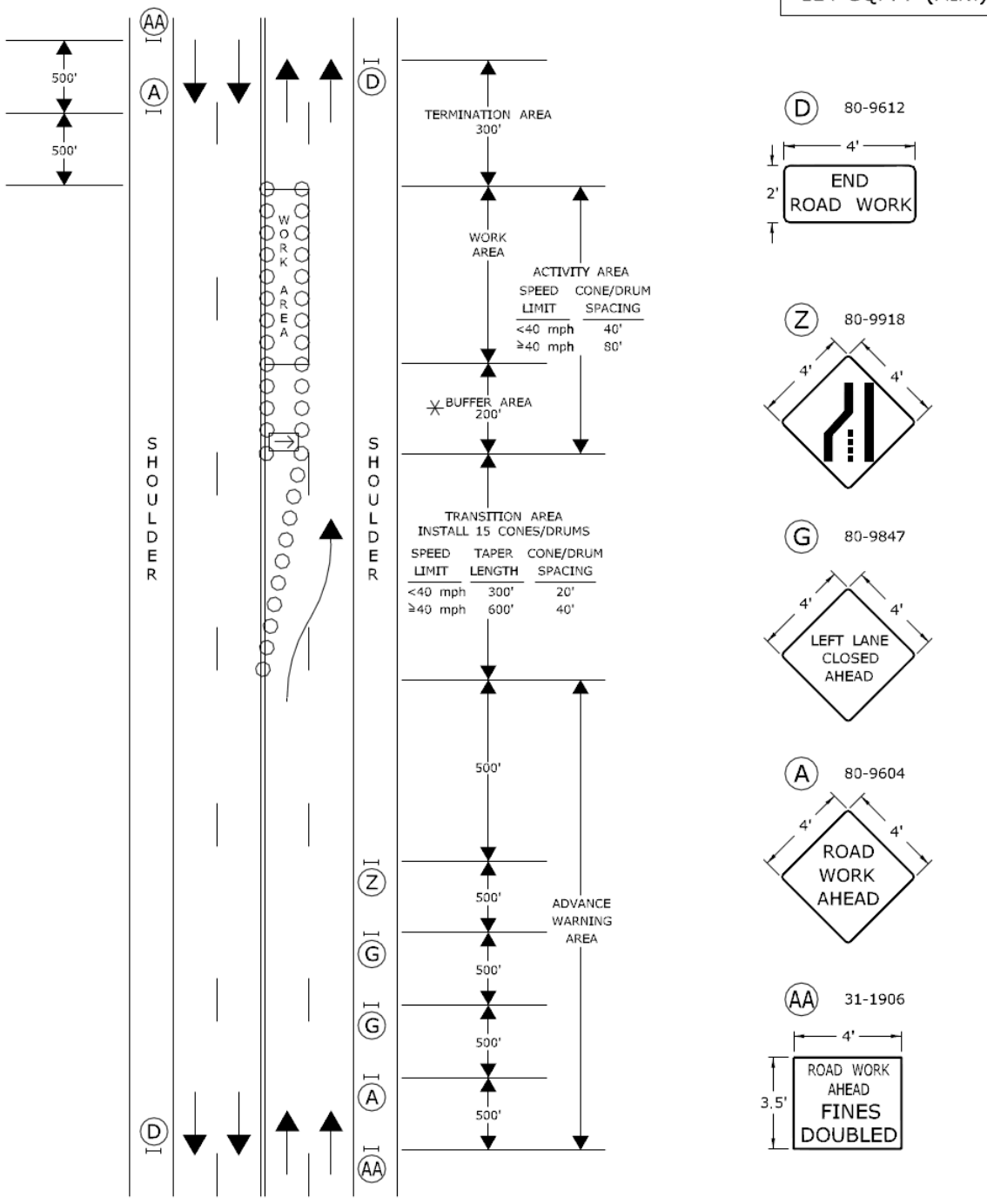
SEE NOTES 1, 2, 3, 4, 5, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:54:15-04'00'
PRINCIPAL ENGINEER

WORK IN LEFT LANE - 4 LANE UNDIVIDED HIGHWAY

SIGN FACE
124 SQ. FT (MIN.)



TRAFFIC CONE **OR** TRAFFIC DRUM
OPTIONAL TRAFFIC DRUM PORTABLE SIGN SUPPORT
HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

PLAN 11

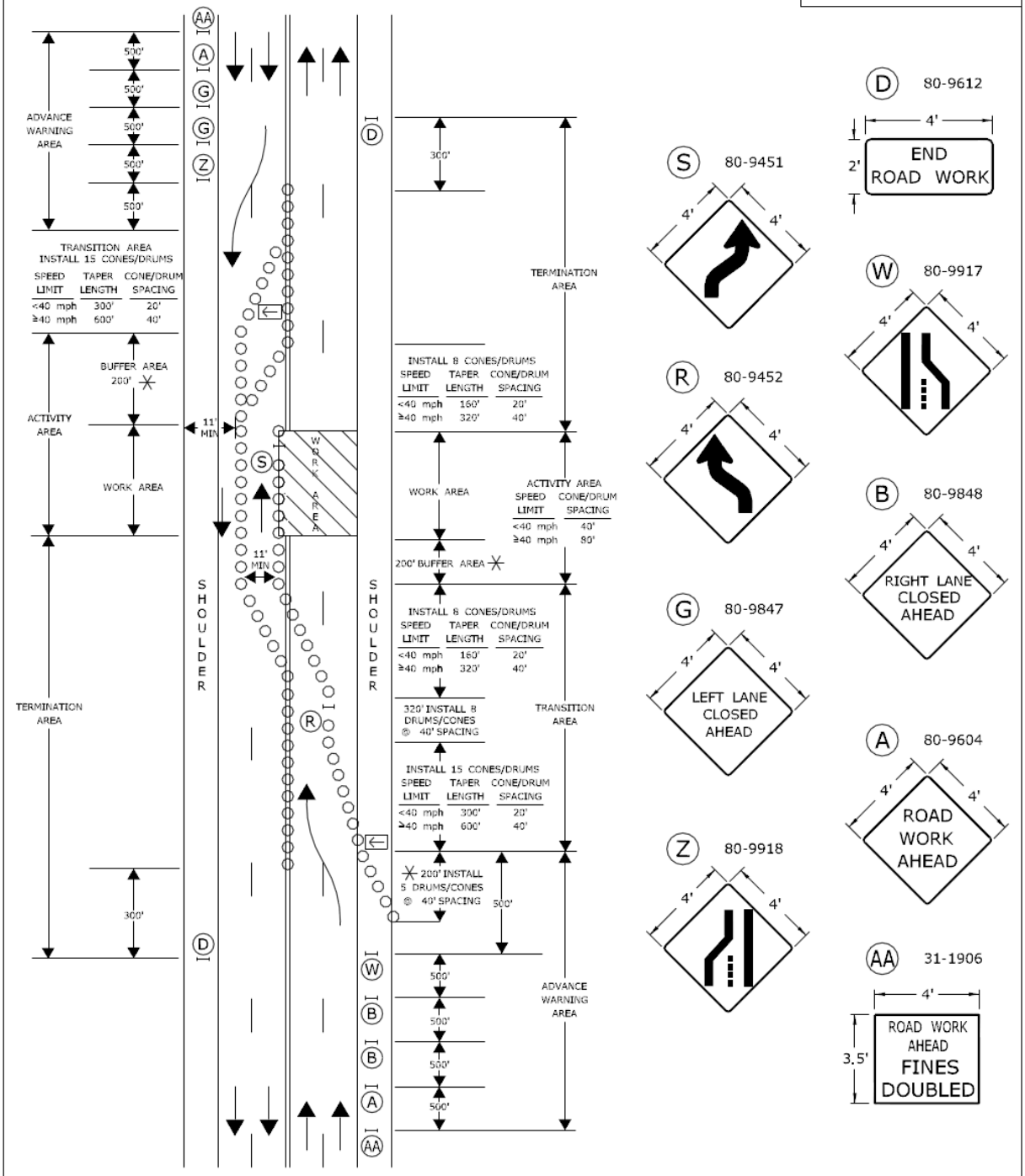
SEE NOTES 1, 2, 3, 4, 5, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:54:36-04'00'
PRINCIPAL ENGINEER

WORK IN BOTH LANES - 4 LANE UNDIVIDED HIGHWAY

SIGN FACE
204 SQ. FT (MIN.)



○ TRAFFIC CONE **OR** TRAFFIC DRUM
✳ OPTIONAL ⊗ TRAFFIC DRUM ⊢ PORTABLE SIGN SUPPORT
⟵ HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

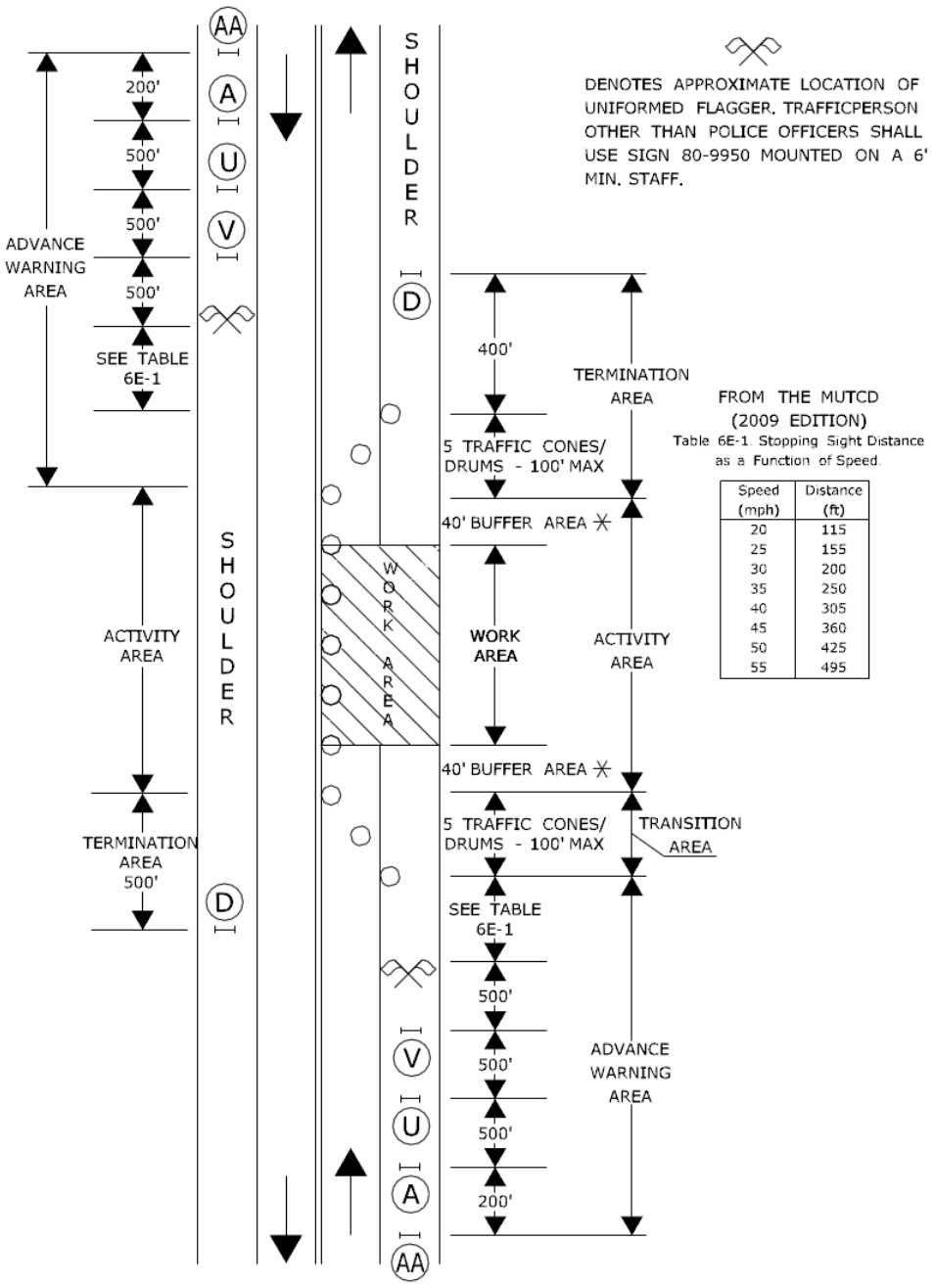
PLAN 12

SEE NOTES 1, 2, 3, 4, 5, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:55:01-04'00'
PRINCIPAL ENGINEER

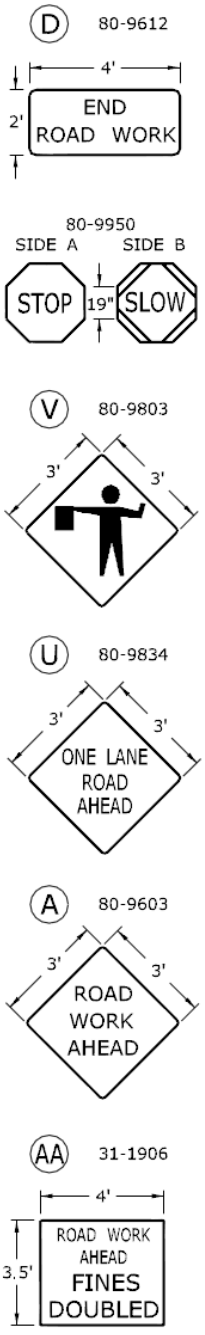
WORK IN TRAVEL LANE AND SHOULDER
TWO LANE HIGHWAY
ALTERNATING ONE-WAY TRAFFIC OPERATIONS



FROM THE MUTCD (2009 EDITION)
Table 6E-1 Stopping Sight Distance as a Function of Speed

Speed (mph)	Distance (ft)
20	115
25	155
30	200
35	250
40	305
45	360
50	425
55	495

SIGN FACE
108 SQ. FT (MIN.)



TRAFFIC CONE **OR** TRAFFIC DRUM
OPTIONAL TRAFFIC DRUM PORTABLE SIGN SUPPORT
HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

PLAN 13 - SHEET 1 OF 2

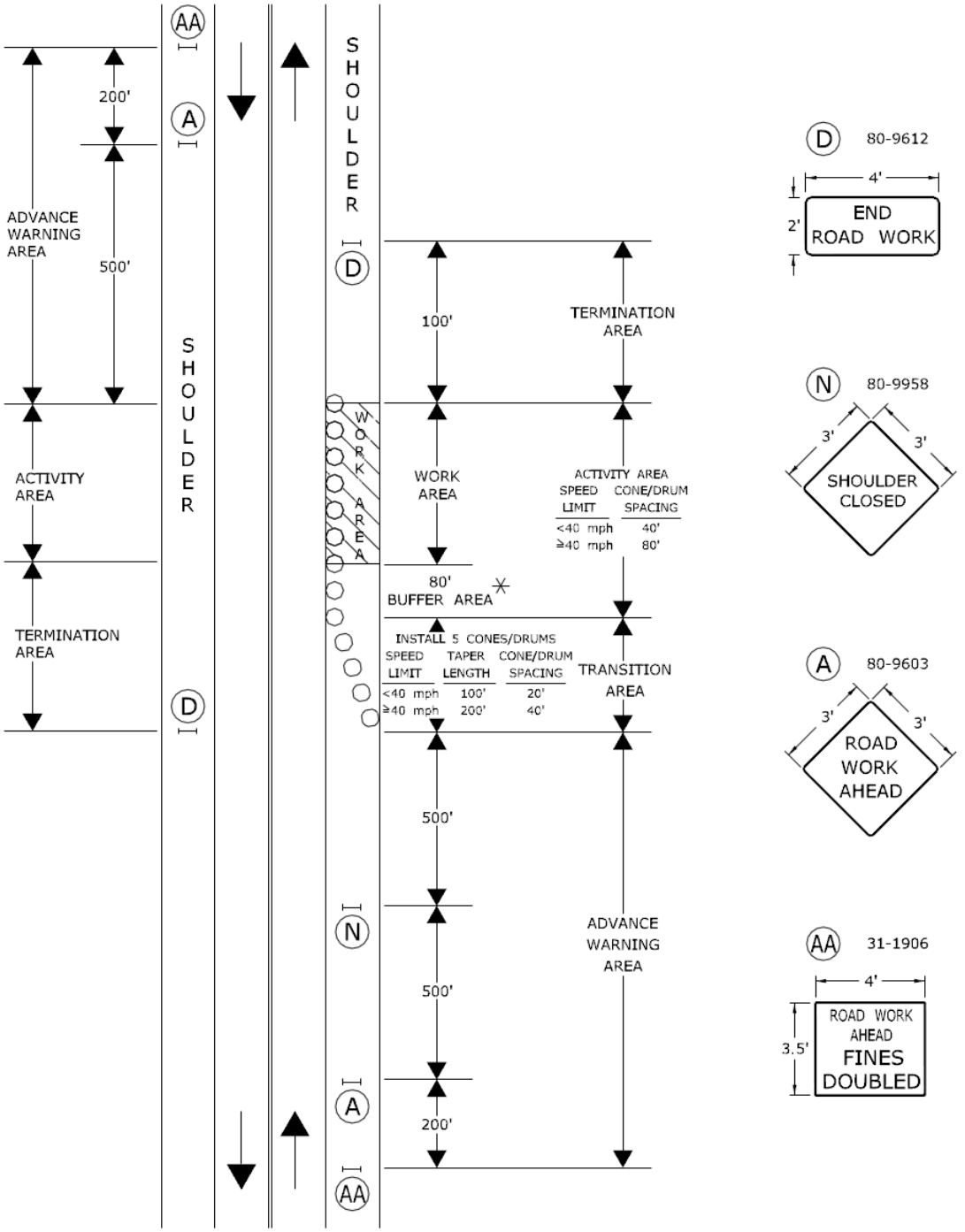
SEE NOTES 1, 2, 4, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:55:23-04'00'
PRINCIPAL ENGINEER

WORK IN SHOULDER - TWO LANE HIGHWAY

SIGN FACE
71 SQ. FT (MIN.)



TRAFFIC CONE **OR** TRAFFIC DRUM
OPTIONAL TRAFFIC DRUM PORTABLE SIGN SUPPORT
HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

PLAN 14

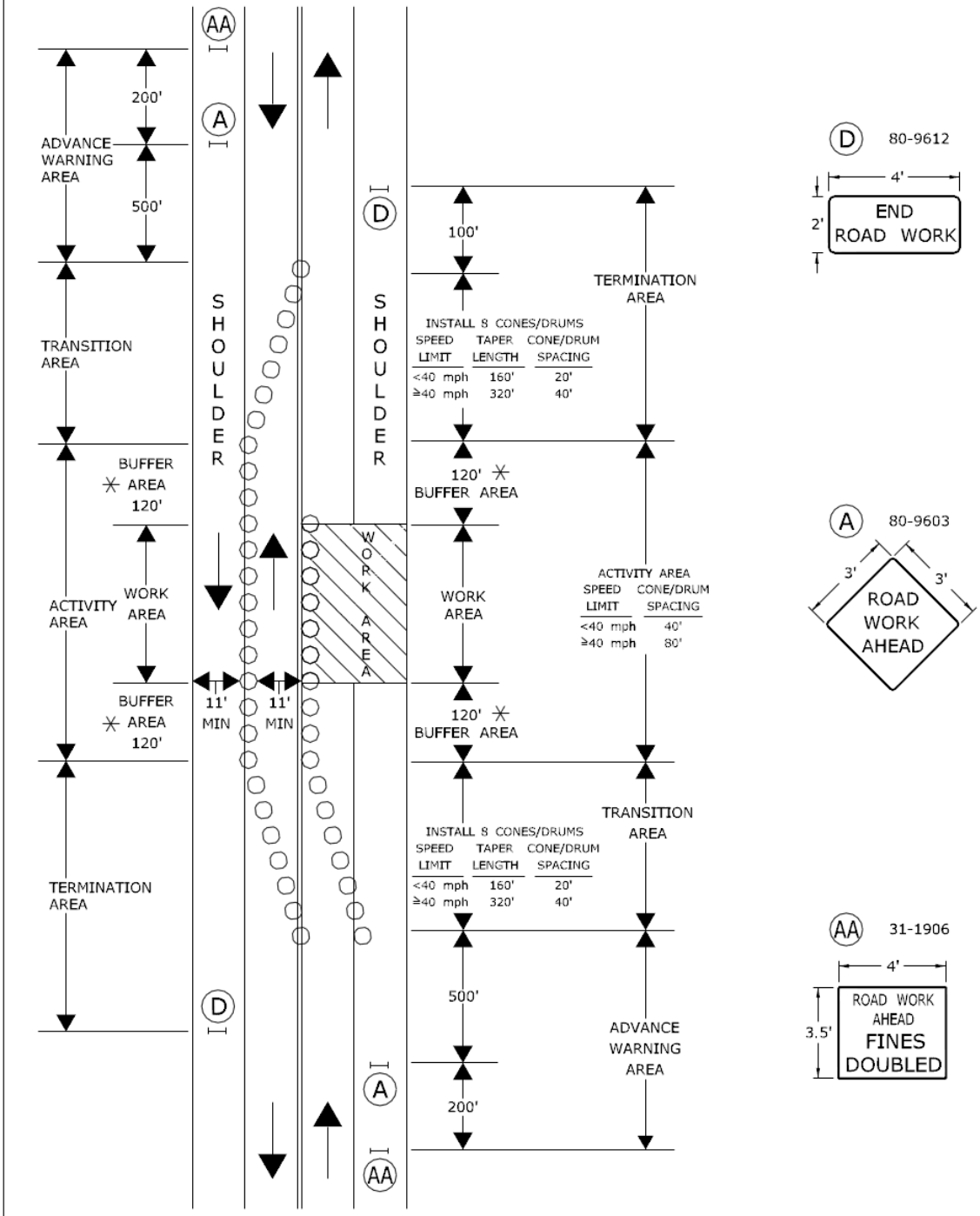
SEE NOTES 1, 2, 4, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:56:09-04'00'
PRINCIPAL ENGINEER

WORK IN TRAVEL LANE AND SHOULDER
TWO LANE HIGHWAY

SIGN FACE
62 SQ. FT (MIN.)



TRAFFIC CONE **OR** TRAFFIC DRUM
OPTIONAL TRAFFIC DRUM PORTABLE SIGN SUPPORT
HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

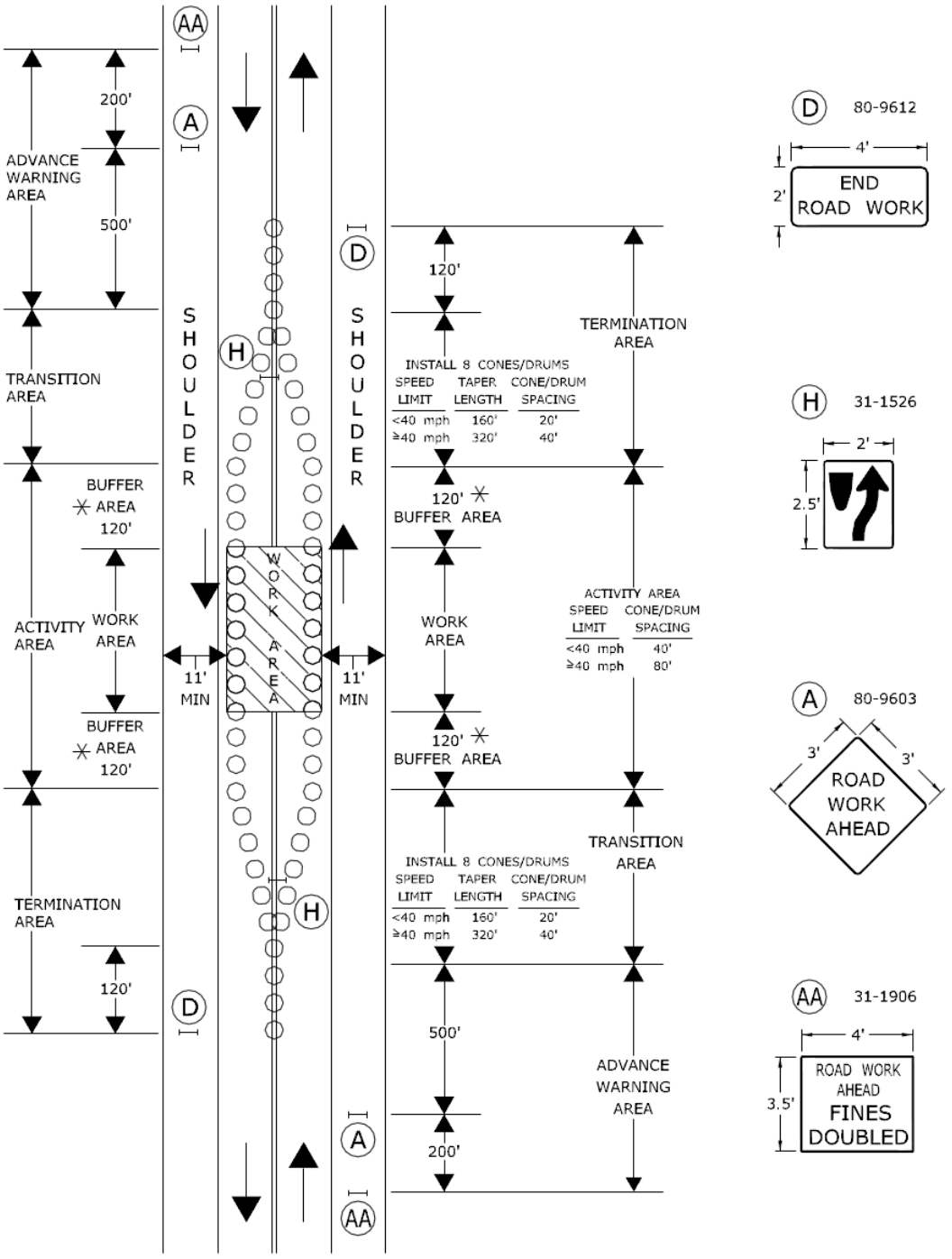
CONSTRUCTION TRAFFIC CONTROL PLAN
PLAN 15
SEE NOTES 1, 2, 4, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:56:29-04'00'
PRINCIPAL ENGINEER

WORK IN MIDDLE OF ROADWAY
TWO LANE HIGHWAY

SIGN FACE
72 SQ. FT (MIN.)



◯ TRAFFIC CONE **OR** TRAFFIC DRUM
✳ OPTIONAL ⊗ TRAFFIC DRUM ⊢ PORTABLE SIGN SUPPORT
⟵ HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

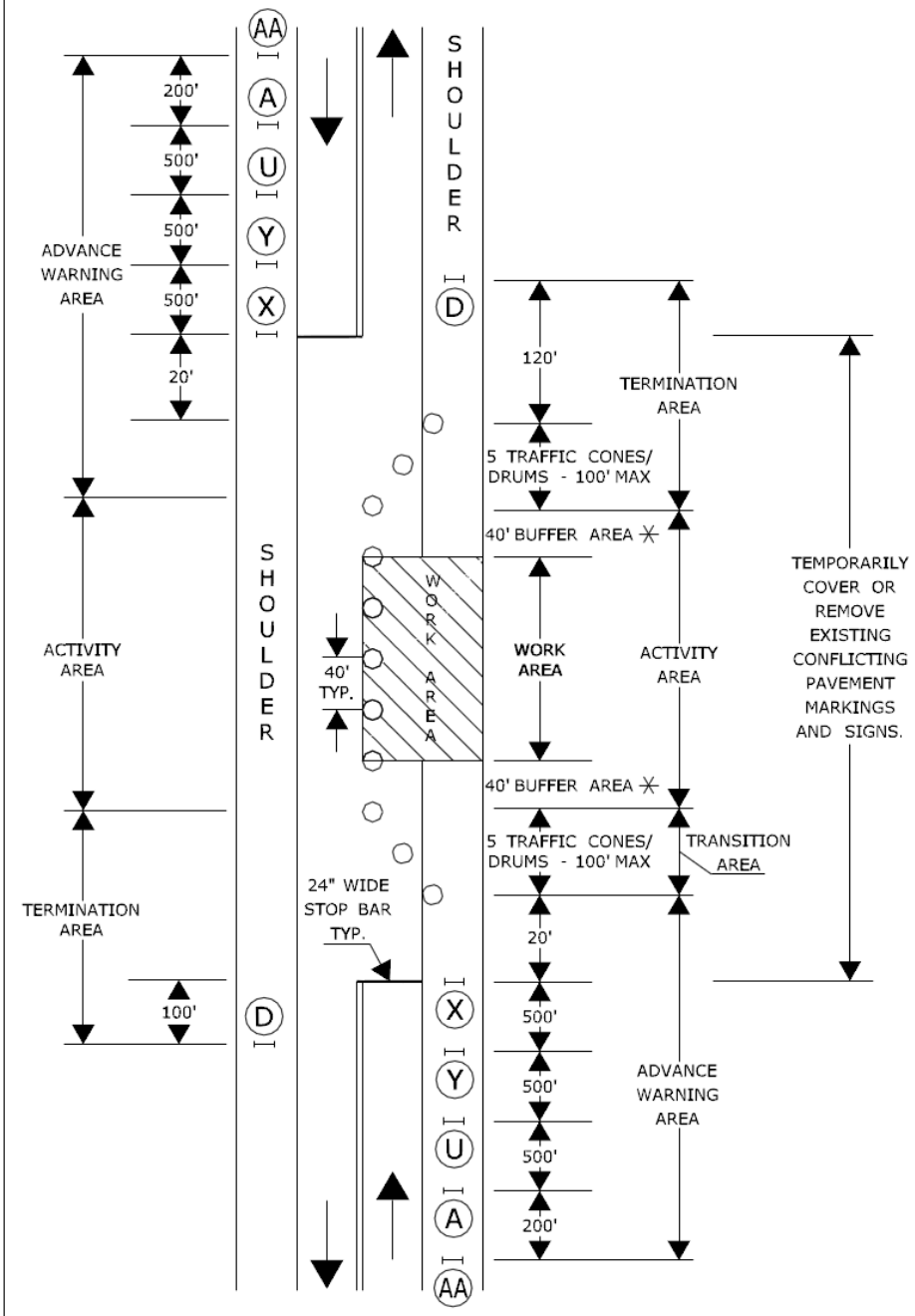
PLAN 16

SEE NOTES 1, 2, 4, 6, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

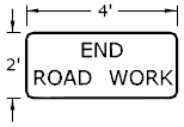
APPROVED Charles S. Harlow 2012.06.05 15:56:51-04'00'
PRINCIPAL ENGINEER

WORK IN TRAVEL LANE AND SHOULDER
TWO LANE HIGHWAY
ALTERNATING ONE-WAY TRAFFIC OPERATIONS
STOP SIGN CONTROL



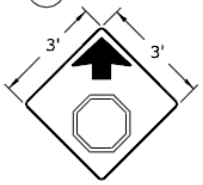
SIGN FACE
125 SQ. FT (MIN.)

D 80-9612



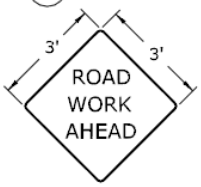
X 31-0557

Y 80-9050

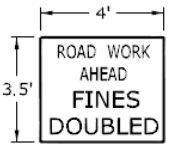


U 80-9834

A 80-9603



AA 31-1906



◯ TRAFFIC CONE **OR** TRAFFIC DRUM
✳ OPTIONAL ⊗ TRAFFIC DRUM ⊢ PORTABLE SIGN SUPPORT
⇐ HIGH MOUNTED INTERNALLY ILLUMINATED FLASHING ARROW

SCALE: NONE

CONSTRUCTION TRAFFIC CONTROL PLAN

PLAN 18

SEE NOTES 1, 2, 4, 7, 8

CONNECTICUT DEPARTMENT OF TRANSPORTATION
BUREAU OF ENGINEERING & CONSTRUCTION

APPROVED Charles S. Harlow 2012.06.05 15:57:37-04'00'
PRINCIPAL ENGINEER

Article 9.71.05 – Basis of Payment is supplemented by the following:

The temporary relocation of signs and supports, and the furnishing, installation and removal of any temporary supports shall be paid for under the item "Maintenance and Protection of Traffic". Temporary overhead sign supports and foundations shall be paid for under the appropriate item(s).

The cost of furnishing, installing, and removing the material for the 4H:1V traversable slope shall be paid for under the item "Maintenance and Protection of Traffic."

ITEM #0979003A - CONSTRUCTION BARRICADE TYPE III

Article 9.79.01 – Description: The Contractor shall furnish construction barricades to conform to the requirements of NCHRP Report 350 (TL-3) and to the requirements stated in Article 9.71 "Maintenance and Protection of Traffic," as shown on the plans and/or as directed by the Engineer.

Article 9.79.02 – Materials: Prior to using the construction barricades, the Contractor shall submit to the Engineer a copy of the Letter of Acceptance issued by the FHWA to the manufacturer documenting that the devices conform to NCHRP Report 350 (TL-3).

Alternate stripes of white and orange Type III or Type VI reflective sheeting shall be applied to the horizontal members as shown on the plans. Application of the reflective sheeting shall conform to the requirements specified by the reflective sheeting manufacturer. Only one type of sheeting shall be used on a barricade and all barricades furnished shall have the same type of reflective sheeting. Reflective sheeting shall conform to the requirements of Article M.18.09.01.

Construction barricades shall be designed and fabricated so as to prevent them from being blown over or displaced by the wind from passing vehicles. Construction barricades shall be approved by the Engineer before they are used.

Article 9.79.03 – Construction Methods: Ineffective barricades, as determined by the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices", shall be replaced by the Contractor at no cost to the State.

Barricades that are no longer required shall be removed from the project and shall remain the property of the Contractor.

Article 9.79.04 – Method of Measurement: Construction Barricade Type III will be measured for payment by the number of construction barricades required and used.

Article 9.79.05 – Basis of Payment: "Construction Barricade Type III" required and used will be paid for at the Contract unit price per each. Each barricade will be paid for once, regardless of the number of times it is used.

Pay Item	Pay Unit
Construction Barricade Type III	EA.

ITEM NO. 0980001A – CONSTRUCTION STAKING

9.80.01—Description: The work under this item shall consist of construction layout and reference staking necessary for the proper control and satisfactory completion of all work on the project, except property lines, highway lines, or non-access lines.

9.80.02—Materials: All stakes used for control staking shall be of the same quality as used by the Department for this purpose. For slope limits, pavement edges, gutter lines, etc., where so-called "green" or "working" stakes are commonly used, lesser quality stakes will be acceptable, provided the stakes are suitable for the intended purpose.

9.80.03—Construction Methods: The Department will furnish the Contractor such control points, bench marks, and other data as may be necessary for the construction staking and layout by qualified engineering or surveying personnel as noted elsewhere herein.

The Contractor shall be responsible for the placement and preservation of adequate ties to all control points, necessary for the accurate re-establishment of all base lines, center lines, and all critical grades as shown on the plans.

All stakes, references, and batter boards which may be required for construction operations, signing and traffic control shall be furnished, set and properly referenced by the Contractor. The Contractor shall be solely and completely responsible for the accuracy of the line and grade of all features of the work. Any errors or apparent discrepancies found in previous surveys, plans, specifications or special provisions shall be called to the Engineer's attention immediately for correction or interpretation prior to proceeding with the work.

During roadway construction (or site work), the Contractor shall provide and maintain for the periods needed, as determined by the Engineer, reference stakes at 100 foot intervals outside the slope limits. Further, the Contractor shall provide and maintain reference stakes at 50 foot intervals immediately prior to and during the formation of subgrade and the construction of all subsequent pavement layers. These stakes shall be properly marked as to station, offset and shall be referenced to the proposed grade, even if laser or GPS machine controls are used.

The Contractor shall provide and maintain reference stakes at drainage structures, including reference stakes for the determination of the structure alignments as may be needed for the proper construction of the drainage structure. The reference stakes shall be placed immediately prior to and maintained during the installation of the drainage structure. These stakes shall be properly marked as to station, offset and shall be referenced to the proposed grade.

The Contractor shall furnish copies of data used in setting and referencing stakes and other layout markings used by the Contractor after completion of each operation.

The Contractor shall provide safe facilities for convenient access by Department forces to control points, batter boards, and references.

All staking shall be performed by qualified engineering or surveying personnel who are trained, experienced and skilled in construction layout and staking of the type required under the contract. Prior to start of work, the Contractor shall submit for review and comment the qualifications of personnel responsible for construction staking on the project. On all projects

with an original contract value greater than $25 million and bridge rehabilitation and reconstruction projects greater than $10 million, surveying shall be performed under the direct supervision of a Professional Surveyor licensed in the State of Connecticut. The submission shall include a description of the experience and training which the proposed staff possesses and a list of state projects the personnel have worked on previously. All field layout and staking required for the project shall be performed under the direct supervision of a person, or persons, of engineering background experienced in the direction of such work and acceptable to the Engineer. If the personnel responsible for construction staking change during the course of the project, then a revised submittal will be required.

The Department may check the control of the work, as established by the Contractor, at any time as the work progresses. The Contractor will be informed of the results of these checks, but the Department by so doing in no way relieves the Contractor of responsibility for the accuracy of the layout work. The Contractor shall correct or replace, at the Contractor's own expense, any deficient layout and construction work which may be the result of the inaccuracies in the Contractor's staking operations or the failure to report such inaccuracies, or the Contractor's failure to report inaccuracies found in work done by the Department or by others. If, as a result of these inaccuracies, the Department is required to make further studies, redesign, or both, all expenses incurred by the Department due to such inaccuracies will be deducted from any monies due the Contractor.

The Contractor shall furnish all necessary personnel, engineering equipment and supplies, materials, transportation, and work incidental to the accurate and satisfactory completion of this work.

For roadways where the existing pavement markings need to be reestablished:

Prior to any resurfacing or obliteration of existing pavement markings, the Contractor and a representative of the Engineer must establish and document pavement marking control points from the existing markings. These control points shall be used to reestablish the positions of the lanes, the beginnings and endings of tapers, channelization lines for on and off ramps, lane use arrows, stop bars, and any lane transitions in the project area. The Contractor shall use these control points to provide appropriate premarking prior to the installation of the final markings.

The Contractor shall provide and maintain reference stakes and/or markings at 100 foot intervals immediately off the edge of pavement to be used to reestablish the existing pavement markings. The Contractor shall also provide and maintain reference stakes and/or markings at any point where there is a change in pavement markings to reestablish the existing pavement markings.

For non-limited access roadways:

On non-limited access roadways it may be necessary to adjust the final locations of the pavement markings to accommodate pedestrians and bicyclists where feasible. Prior to any resurfacing or obliteration of existing pavement markings, the Contractor, a representative of the Engineer, and a representative of the Division of Traffic Engineering must establish and document pavement marking control points from the existing markings as described above. The control points at that time may be adjusted to provide minimum shoulder widths of 4 to 5 feet wherever possible while maintaining travel lane widths of no less than 11 feet and no more than 12 feet.

For work along and within the Amtrak right-of-way:

Refer to the following:

Notice to Contractor – Work on Railroad Property
Notice to Contractor – Amtrak Specifications
Notice to Contractor – Track Monitoring
Notice to Contractor – Railroad Safety Training
Notice to Contractor – Pedestrian Bridge Structures
Notice to Contractor – Platform Construction
Divisions 1 and 2 – General Requirements of the CSI-Formatted Specifications

9.80.04—Method of Measurement: Construction staking will be at the Contract lump sum for construction staking. When no price for "Construction Staking" is asked for on the proposal form, the cost of the work described above shall be included in the general cost of the work and no direct payment for "Construction Staking" will be made.

9.80.05—Basis of Payment: Construction staking will be paid for at the Contract lump sum price for "Construction Staking," which price shall include all materials, tools, equipment, labor and work incidental thereto. A schedule of values for payment shall be submitted to the Department for review and comment prior to payment.

Pay Item	Pay Unit
Construction Staking	l.s.

ITEM #0999001A - DISPOSAL OF BUILDINGS

Work under this item shall conform to the requirements of Section 9.99 supplemented as follows:

It is estimated that the buildings listed in the proposal will be vacated and asbestos abatement completed on or before DATE TBD BY CTDOT ENVIRONEMTNAL COMPLIANCE.

ITEM NO. 1206023A - REMOVAL AND RELOCATION OF EXISTING SIGNS

Section 12.06 is supplemented as follows:

Article 12.06.01 – Description is supplemented with the following:
Work under this item shall consist of the removal and/or relocation of designated side-mounted extruded aluminum and sheet aluminum signs, sign posts, sign supports, and foundations where indicated on the plans or as directed by the Engineer. Work under this item shall also include furnishing and installing new sign posts and associated hardware for signs designated for relocation.

Article 12.06.03 – Construction Methods is supplemented with the following:
The Contractor shall take care during the removal and relocation of existing signs, sign posts, and sign supports that are to be relocated so that they are not damaged. Any material that is damaged shall be replaced by the Contractor at no cost to the State.

Foundations and other materials designated for removal shall be removed and disposed of by the Contractor as directed by the Engineer and in accordance with existing standards for Removal of Existing Signing.

Sheet aluminum signs designated for relocation are to be re-installed on new sign posts.

Article 12.06.04 – Method of Measurement is supplemented with the following:
Payment under Removal and Relocation of Existing Signs shall be at the contract lump sum price which shall include all extruded aluminum and sheet aluminum signs, sign posts, and sign supports designated for relocation, all new sign posts and associated hardware for signs designated for relocation, all extruded aluminum signs, sheet aluminum signs, sign posts and sign supports designated for scrap, and foundations and other materials designated for removal and disposal, and all work and equipment required.

Article 12.06.05 – Basis of Payment is supplemented with the following:
This work will be paid for at the contract lump sum price for "Removal and Relocation of Existing Signs" which price shall include relocating designated extruded aluminum and sheet aluminum signs, sign posts, and sign supports, providing new posts and associated hardware for relocated signs, removing and disposing of foundations and other materials, and all equipment, material, tools and labor incidental thereto. This price shall also include removing, loading, transporting, and unloading of extruded aluminum signs, sheet aluminum signs, sign posts, and sign supports designated for scrap and all equipment, material, tools and labor incidental thereto.

Pay Item	Pay Unit
Removal and Relocation of Existing Signs	L.S.

ITEM # 1210101A – 4" WHITE EPOXY RESIN PAVEMENT MARKINGS

ITEM # 1210102A – 4" YELLOW EPOXY RESIN PAVEMENT MARKINGS

ITEM # 1210105A – EPOXY RESIN PAVEMENT MARKINGS, SYMBOLS AND LEGENDS

ITEM # 1210106A – 12" WHITE EPOXY RESIN PAVEMENT MARKINGS

SECTION 12.10 – EPOXY RESIN PAVEMENT MARKINGS, SYMBOLS AND LEGENDS is amended as follows:

*Delete "**SYMBOLS AND LEGENDS**" from the title of the section.*

SECTION 12.10.03 – Construction Methods is amended as follows:

*Delete the entire section titled "**WARRANTY**" under item number **3. Performance and Warranty.***

It was determined by the Office of Construction that the *First Year* warranty requirement is not necessary because early test results generally depict the outcome of pavement markings.

ITEM #1220011A - CONSTRUCTION SIGNS – TYPE III REFLECTIVE SHEETING

Article 12.20.01 – **Description:** The Contractor shall furnish construction signs with Type III reflective sheeting and their required portable supports or metal sign posts that conform to the requirements of NCHRP Report 350 (TL-3) and to the signing requirements stated in Article 9.71 "Maintenance and Protection of Traffic," as shown on the plans and/or as directed by the Engineer.

Article 12.20.02 – Materials: Prior to using the construction signs and their portable supports, the Contractor shall submit to the Engineer a copy of the Letter of Acceptance issued by the FHWA to the manufacturer documenting that the devices (both sign and portable support tested together) conform to NCHRP Report 350 (TL-3).

Portable sign supports shall be designed and fabricated so that the signs do not blow over or become displaced by the wind from passing vehicles. Portable sign supports shall be approved by the Engineer before they are used.

Mounting height of signs on portable sign supports shall be a minimum of 1 foot and a maximum of 2 feet, measured from the pavement to the bottom of the sign.

All sign faces shall be rigid and reflectorized. Reflective sheeting shall conform to the requirements of Article M.18.09.01 (Type III). Sheet aluminum sign blanks shall conform to the requirements of Article M.18.13. Metal sign posts shall conform to the requirements of Article M.18.14. Application of reflective sheeting, legends, symbols, and borders shall conform to the requirements specified by the reflective sheeting manufacturer. Attachments shall be provided so that the signs can be firmly attached to the portable sign supports or metal posts without causing damage to the signs.

The following types of construction signs shall not be used: mesh, non-rigid, roll-up.

The following portable sign support systems or equivalent systems that meet the above requirements may be used:

- Korman Model #SS548 flexible sign stand with composite aluminum sign substrate (APOLIC)

- Traffix "Little Buster" dual spring folding sign stand with corrugated polyethylene (0.4 in. thick) sign substrate (InteCel)

Article 12.20.03 – Construction Methods: Ineffective signs, as determined by the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices", shall be replaced by the Contractor at no cost to the State.

Signs and their portable supports or metal posts that are no longer required shall be removed from the project and shall remain the property of the Contractor.

Article 12.20.04 – Method of Measurement: Construction Signs - Type III Reflective Sheeting will be measured for payment by the number of square feet of sign face. Sign supports will not be measured for payment.

Article 12.20.05 – Basis of Payment: "Construction Signs – Type III Reflective Sheeting" required and used on the project will be paid for at the Contract unit price per square foot. This price shall include the furnishing and maintenance of the signs, portable sign supports, metal sign posts and all hardware. Each sign and support or posts will be paid for once, regardless of the number of times it is used.

Pay Item	Pay Unit
Construction Signs – Type III Reflective Sheeting	S.F.

ITEM #1220013A – CONSTRUCTION SIGNS - BRIGHT FLUORESCENT SHEETING

Article 12.20.01 – Description: The Contractor shall furnish construction signs with bright fluorescent sheeting and their required portable supports or metal sign posts that conform to the requirements of NCHRP Report 350 (TL-3). The construction signs and their required portable supports or metal sign posts shall conform to the signing requirements stated in Article 9.71 "Maintenance and Protection of Traffic", as shown on the plans and/or as directed by the Engineer.

Article 12.20.02 – Materials: Prior to using the construction signs and their portable supports, the Contractor shall submit to the Engineer a copy of the Letter of Acceptance issued by the FHWA to the manufacturer documenting that the devices (both sign and portable support tested together) conform to NCHRP Report 350 (TL-3).

Portable sign supports shall be designed and fabricated so as to prevent signs from being blown over or displaced by the wind from passing vehicles. Portable sign supports shall be approved by the Engineer before they are used. Mounting height of signs on portable sign supports shall be a minimum of 1 foot and a maximum of 2 feet, measured from the pavement to the bottom of the sign.

All sign faces shall be rigid and reflectorized. Sheet aluminum sign blanks shall conform to the requirements of Article M.18.13. Metal sign posts shall conform to the requirements of Article M.18.14. Application of reflective sheeting, legends, symbols, and borders shall conform to the requirements specified by the reflective sheeting manufacturer. Attachments shall be provided so that the signs can be firmly attached to the portable sign supports or metal posts without causing damage to the signs. A Materials Certificate and Certified Test Report conforming to Article 1.06.07 shall be required for the reflective sheeting.

The following types of construction signs shall not be used: mesh, non-rigid, roll-up, corrugated or waffle board types substrates, foam core and composite aluminum sign substrates.

Reflective sheeting shall conform to the following:
The fluorescent orange prismatic retroreflective sheeting shall consist of prismatic lenses formed in a transparent fluorescent orange synthetic resin, sealed, and backed with an aggressive pressure sensitive adhesive protected by a removable liner. The sheeting shall have a smooth surface.

Physical Properties:

A. Photometric - Coefficient of Retroreflection R_A

When the sheeting applied on test panels is measured in accordance with ASTM E 810, it shall have minimum coefficient of retroreflection values as shown in Table I. The rotation angle shall be as designated by the manufacturer for test purposes, the observation angles

shall be 0.2 degrees and 0.5 degrees, the entrance angles (component B_1) shall be -4 degrees and +30 degrees.

TABLE I

Minimum Coefficient of Retroreflection R_A
Candelas per footcandle per square foot

Observation Angle (deg.)	Entrance Angle (deg.)	R_A Orange
0.2	- 4	200
0.2	+ 30	90
0.5	- 4	80
0.5	+ 30	50

The rotation shall be as designated by the manufacturer.

B. Daytime Color

Color shall conform to the requirements of Table II. Daytime color and maximum spectral radiance factor (peak reflectance) of sheeting mounted on test panels shall be determined instrumentally in accordance with ASTM E 991. The values shall be determined on a Hunter Lab Labscan 6000 0/45 Spectrocolorimeter with option CMR 559 (or approved equal 0/45 instrument with circumferential viewing illumination). Computations shall be done in accordance with ASTM E 308 for the 2 degree observer.

TABLE II

Color Specification Limits** (Daytime)

Color	1		2		3		4		Reflectance Limit Y (%)	
	X	Y	X	Y	X	Y	X	Y	MIN	MAX
Orange (new)	.583	.416	.523	.397	.560	.360	.631	.369	28	-
Orange (weathered)	.583	.416	.523	.397	.560	.360	.631	.369	20	45

Maximum Spectral Radiance Factor, new: 110%, min.
weathered: 60%, min.

** The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65.

C. Nighttime Color

Nighttime color of the sheeting applied to test panels shall be determined instrumentally in accordance with ASTM E 811 and calculated in the u', v' coordinate system in accordance with ASTM E 308. Sheeting shall be measured at 0.33 degrees observation

and -4 degree entrance at rotation as determined by the manufacturer for test purposes. Color shall conform to the requirements of Table III.

TABLE III

Color Specification Limits ** (Nighttime)

Color	1		2		3		4	
	u'	v'	u'	v'	u'	v'	u'	v'
Orange (new and weathered)	.400	.540	.475	.529	.448	.522	.372	.534

D. Resistance to Accelerated Weathering

The retroreflective surface of the sheeting shall be weather resistant and show no appreciable cracking, blistering, crazing, or dimensional change after one year's unprotected outdoor exposure in south Florida, south-facing and inclined 45 degrees from the vertical, or after 1500 hours exposure in a xenon arc weatherometer in accordance with ASTM G26, Type B, Method A. Following exposure, panels shall be washed in a 5% HCL solution for 45 seconds, rinsed thoroughly with clean water, blotted with a soft clean cloth and brought to equilibrium at standard conditions. After cleaning, the coefficient of retroreflection shall be not less than 100 when measured as in D.2, below, and the color is expected to conform to the requirements of Tables II and III for weathered sheeting. The sample shall:

1. Show no appreciable evidence of cracking, scaling, pitting, blistering, edge lifting or curling or more than 0.031 inch shrinkage or expansion.

2. Be measured only at angles of 0.2 degrees observation, -4 degrees entrance, and rotation as determined by the manufacturer for test purposes. Where more than one panel of color is measured, the coefficient of retroreflection shall be the average of all determinations.

E. Impact Resistance

The retroreflective sheeting applied according to the manufacturer's recommendations to a test panel of alloy 6061-T6, 0.040 inch by 3 inches by 5 inches and conditioned for 24 hours, shall show no cracking outside the impact area when the face of the panel is subjected to an impact of 100 inch-pounds, using a weight with a 0.625 inch diameter rounded tip dropped from a height necessary to generate an impact of 100 inch-pounds, at test temperatures of both 32° F and 72° F.

F. Resistance to Heat

The retroreflective sheeting, applied to a test panel as in E., above, and conditioned for 24 hours, shall be measured in accordance with Paragraph A. at 0.2 degree observation and -4 degree entrance angles at rotation as determined by the manufacturer for test purposes and

exposed to 170° ± 5° F for 24 hours in an air circulating oven. After heat exposure the sheeting shall retain a minimum of 70% of the original coefficient of retroreflection.

G. Field Performance:

Retroreflective sheeting processed and applied to sign blank materials in accordance with the sheeting manufacturer's recommendations, shall perform effectively for a minimum of 3 years. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that: (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or (2) the coefficient of retroreflection is less than 100 when measured at 0.2 degrees observation and -4 degree entrance. All measurements shall be made after sign cleaning according to the sheeting manufacturer's recommendations.

Article 12.20.03 – Construction Methods: Ineffective signs, as determined by the Engineer and in accordance with the ATSSA guidelines contained in "Quality Standards for Work Zone Traffic Control Devices", shall be replaced by the Contractor at no cost to the State.

Signs and their portable sign supports or metal posts that are no longer required shall be removed from the project and shall remain the property of the Contractor.

Article 12.20.04 – Method of Measurement: Construction Signs - Bright Fluorescent Sheeting will be measured for payment by the number of square feet of sign face. Sign supports will not be measured for payment.

Article 12.20.05 – Basis of Payment: "Construction Signs - Bright Fluorescent Sheeting" required and used on the project will be paid for at the Contact unit price per square foot. This price shall include the furnishing and maintenance of the signs, portable sign supports, metal sign posts and all hardware. Each sign and support or posts will be paid for once, regardless of the number of times it is used.

Pay Item	Pay Unit
Construction Signs – Bright Fluorescent Sheeting	S.F.

ITEM # 1700001A – SERVICE CONNECTIONS (ESTIMATED COST)

Description: This work shall consist of disconnection, alteration and reconnection of those existing utility services owned by property owners at locations necessary to complete this project and as ordered by the Engineer. This work shall include the coordination with the affected utility companies and customers. Any damage caused by the Contractor or Subcontractors, as determined by the Engineer, shall be corrected by the Contractor in accordance with this specification.

Materials: All materials shall be provided by the Contractor and shall meet the current standards of the affected service.

Construction Methods: The Contractor shall perform all work in coordination with the Utility Company and affected property owner and as directed by the Engineer. Certain work may require use of a licensed and/or certified tradesman when such work is required by local and/or state codes.

Any utility customer's service interruption shall be done in a way that minimizes adverse impacts to the customer and affected utility.

Any work and materials supplied by the utility companies shall be on a billable basis to the Contractor.

Method of Measurement: The work and materials shall be measured for payment as provided for under Article 1.04.05 Extra Work.

The sum of money shown on the estimate and in the itemized proposal as "Estimated Cost" for this work will be considered the price bid even though payment will be made only for actual work performed. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figure will be disregarded and the original price will be used to determine the total amount for the contract.

Corrective work required to repair damage caused by the Contractor or its Subcontractors shall not be measured for payment.

Basis of Payment: This work will be paid as Extra Work.

Pay Item	**Pay Unit**
Service Connections (Estimated Cost)	Estimated Cost

INDEX OF CSI FORMATTED SPECIFICATIONS

Note: This index has been prepared for the convenience of those using this contract with the sole express purpose of locating quickly the information contained herein; and no claims shall arise due to omissions, additions, deletions, etc., as this index shall not be considered part of the contract.

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01142A Submission Documentation Required For Amtrak Review and Approval of Plans for Bridge Erection, Demolition and Other Crane/ Hoisting Operations over Railroad Right -Of-Way (AMTRAK)

01520A Requirements for Temporary Protection Shields For Demolition and Construction of Overhead Bridges and Other Structures (AMTRAK)

02261A Requirements for Temporary Sheeting and Shoring to Support Amtrak Tracks (AMTRAK)

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END OF INDEX OF CSI FORMATTED SPECIFICATIONS

SECTION 01141A -SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY

PART 1 -GENERAL

1.1 SCOPE

A. This specification describes the safety procedures and protection provisions for Contractors and Permittees entering and working upon railroad property.

B. Use of this specification is as required by Amtrak, as described in Amtrak Engineering Practice EP3014.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. CHIEF ENGINEER: Amtrak Chief Engineer

B. RAILROAD: National Railroad Passenger Corporation (Amtrak), and/or the duly authorized representative

C. ENGINEERING PRACTICE: Amtrak Engineering Practices establish a system of uniform practices, notices and instructions for the Amtrak Engineering Department, providing current, permanent and temporary, departmental procedures and policies.

PART 2 -PRODUCTS (Not Used)

PART 3 -EXECUTION

3.1 PRE-ENTRY MEETING

A. Before entry of Permittee and/or Contractors onto Railroad's property, a pre-entry meeting shall be held at which time Permittee and/or Contractors shall submit for written approval of the Chief Engineer, plans, computations and a detailed description of proposed methods for accomplishing the work, including methods for protecting Railroad's traffic. Any such written approval shall not relieve Permittee and/or Contractor of their complete responsibility for the adequacy and safety oftheir operations.

3.2 RULES, REGULATIONS AND REQUIREMENTS

A. Railroad traffic shall be maintained at all times with safety and continuity, and Permittee and/or Contractors

shall conduct their operations in compliance with all rules, regulations, and requirements of Railroad (including these Specifications) with respect to any work performed on, over, under, within or adjacent to Railroad's property. Permittee and/or Contractors shall be responsible for acquainting themselves with such rules, regulations and requirements. Any violation of Railroads safety rules, regulations, or requirements shall be grounds for the immediate suspension of the Permittee and/or Contractor work, and the re-training of all personnel, at the Permittee's expense.

3.3 MAINTENANCE OF SAFE CONDITIONS

A. If tracks or other property of Railroad are endangered during the work, Permittee and/or Contractor shall immediately take such steps as may be directed by Railroad to restore safe conditions, and upon failure of Permittee and/or Contractor to immediately carry out such direction, Railroad may take whatever steps are reasonably necessary to restore safe conditions. All costs and expenses of restoring safe conditions, and of repairing any damage to Railroad's trains, tracks, right-of-way or other property caused by the operations of Permittee and/or Contractors, shall be paid by Permittee.

3.4 PROTECTION IN GENERAL

A. Permittee and/or Contractors shall consult with the Chief Engineer to determine the type and extent of protection required to insure safety and continuity of railroad traffic. Any Inspectors, Track Foremen, Track Watchmen, Flagman, Signalmen, Electric Traction Linemen, or other employees deemed necessary by Railroad, at its sole discretion, for protective services shall be obtained from Railroad by Permittee and/or Contractors. The cost of same shall be paid directly to Railroad by Pennittee. The provision of such employees by Railroad, and any other precautionary measures taken by Railroad, shall not relieve Permittee and/or Contractors from their complete responsibility for the adequacy and safety oftheir operations.

3.5 PROTECTION FOR WORK NEAR ELECTRIFIED TRACK OR WIRE

A. Whenever work is performed in the vicinity of electrified tracks and/or high voltage wires, particular care must be exercised, and Railroad's requirements regarding clearance to be maintained between equipment and tracks and/or energized wires, and otherwise regarding work in the vicinity of electrified tracks, must be strictly observed. No employees or equipment will be permitted to work near overhead wires, except when protected by a Class A employee of Railroad. **Permittee and/or Contractors must supply an adequate length of grounding cable (4/0 copper with approved clamps) for each piece of equipment working near or adjacent to any overhead wire.**

3.6 FOULING OF TRACK OR WIRE

A. No work will be permitted within twenty-five (25) feet of the centerline of track or the energized wire or have potential of getting within twenty-five (25) feet of track wire without the approval of the Chief Engineer's representative. Permittee and/or Contractors shall conduct their work so that no part of any equipment or material shall foul an active track or overhead wire without the written permission of the Chief Engineer's representative. When Permittee and/or Contractors desire to foul an active track, they must provide the Chief Engineer's representative with their site-specific work plan a minimum of twenty-one (21) working days in advance, so that, if approved, arrangements may be made for proper protection of Railroad. Any equipment shall be considered to be fouling a track or overhead wire when located (a) within fifteen

(15) feet from the centerline of the track or within fifteen (15) feet from the wire, or (b) in such a position that failure of same, with or without a load, would bring it within fifteen (15) feet from the centerline of the track or within fifteen (15) feet from the wire and requires the presence of the proper Railroad protection personnel.

B. If acceptable to the Chief Engineer' s representative, a safety barrier (approved temporary fence or barricade) may be installed at fifteen (15) feet from centerline of track or overhead wire to afford the Permittee and/or Contractor with a work area that is not considered fouling. Nevertheless, protection personnel may be required at the discretion of the Chief Engineer's representative.

3.7 TRACK OUTAGES

A. Permittee and/or Contractors shall verify the time and schedule of track outages from Railroad before scheduling any of their work on, over, under, within, or adjacent to Railroad's right-of-way. Railroad does not guarantee the availability of any track outage at any particular time. Permittee and/or Contractors shall schedule all work to be performed in such a manner as not to interfere with Railroad operations. Permittee and/or Contractors shall use all necessary care and precaution to avoid accidents, delay or interference with Railroad's trains or other property.

3.8 DEMOLITION

A. During any demolition, the Contractor must provide horizontal and vertical shields, designed by a Professional Engineer registered in the state in which the work takes place. These shields shall be designed in accordance with the Railroad's specifications and approved by the Railroad, so as to prevent any debris from falling onto the Railroad's right-of-way or other property. A grounded temporary vertical protective barrier must be provided if an existing vertical protective barrier is removed during demolition. In addition, if any openings are left in an existing bridge deck, a protective fence must be erected at both ends of the bridge to prohibit unauthorized persons from entering onto the bridge.

B. Ballasted track structure shall be kept free of all construction and demolition debris. Geotextiles or canvas shall be placed over the track ties and ballast to keep the ballast clean.

3.9 EQUIPMENT CONDITION

A. All equipment to be used in the vicinity of operating tracks shall be in "certified" first-class condition so as to prevent failures that might cause delay to trains or damage to Railroad's property. No equipment shall be placed or put into operation near or adjacent to operating tracks without first obtaining permission from the Chief Engineer's representative. **Under no circumstances shall any equipment or materials be placed or stored within twenty-five (25) feet from the centerline of an outside track, except as approved by the Site Specific Safety Work Plan.** To insure compliance with this requirement, Permittee and/or Contractors **must establish a twenty-five (25) foot foul line prior to the start of work** by either driving stakes, taping off or erecting a temporary fence, or providing an alternate method as approved by the Chief Engineer's representative. Permittee and/or Contractors will be issued warning stickers which must be placed in the operating cabs of all equipment as a constant reminder of the twenty-five (25) foot clearance envelope.

3.10 STORAGE OF MATERIALS AND EQUIPMENT

A. No material or equipment shall be stored on Railroad's property without first having obtained permission from the Chief Engineer. Any such storage will be on the condition that Railroad will not be liable for loss of or damage to such materials or equipment from any cause.

B. If permission is granted for the storage of compressed gas cylinders on Railroad property, they shall be stored a minimum of 25 feet from the nearest track in an approved lockable enclosure. The enclosure shall be locked when the Permittee and/or Contractor is not on the project site.

3.11 CONDITION OF RAILROAD'S PROPERTY

A. Permittee and/or Contractors shall keep Railroad's property clear of all refuse and debris from its operations. Upon completion of the work, Permittee and/or Contractors shall remove from Railroad's property all machinery, equipment, surplus materials, falsework, rubbish, temporary structures, and other property of the Permittee and/or Contractors and shall leave Railroad's property in a condition satisfactory to the Chief Engineer.

3.12 SAFETY TRAINING

A. All individuals, including representatives and employees of the Permittee and/or Contractors, before entering onto Railroad's property or coming within twenty-five (25) feet of the centerline of the track or energized wire shall first attend Railroad's Safety Contractor/Leasee Employee Training Class. The Safety Orientation Class will be provided by Railroad's Safety Representative at Permittee's expense. A photo I.D. will be issued and must be worn/displayed while on Railroad property. All costs of complying with Railroad's safety training shall be at the sole expense of Permittee. Permittee and/or Contractors shall appoint a qualified person as their Safety Representative. The Safety Representative shall continuously assure that all individuals comply with Railroad's safety requirements. All safety training records shall be maintained with site specific work plan.

3.13 NO CHARGES TO RAILROAD

A. It is expressly understood that neither these Specifications, nor any document to which they are attached, include any work for which Railroad is to be billed by Permittee and/or Contractors, unless Railroad gives a written request that such work be performed at Railroad's expense.

END OF SECTION 01141A

SECTION 01142A -SUBMISSION DOCUMENTATION REQUIRED FOR AMTRAK REVIEW AND APPROVAL OF PLANS FOR BRIDGE ERECTION, DEMOLITION AND OTHER CRANE/ HOISTING OPERATIONS OVER RAILROAD RIGHT -OF-WAY

PART 1 -GENERAL

1.1 SCOPE

A. Amtrak requires that a site-specific work plan for accomplishing hoisting operations be prepared for every applicable project, and for each type of lift on a project.
   1. The plan shall demonstrate adherence to Amtrak safety rules.
   2. The plan shall demonstrate constructability.
   3. The plan shall minimize impact to rail operations.
   4. The approved plan will provide the basis for field inspection and verification of the actual work.

B. Preparation, review and approval of the Crane/ Hoisting site-specific work plan does not relieve the Contractor from meeting other Amtrak requirements for adequate planning and documentation of proposed work procedures within the Right-of-Way of the railroad.

C. Current Amtrak safety rules shall be adhered to in every respect.

D. Use of this specification is as required by Amtrak, as described in Amtrak Engineering Practice EP3014.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division I Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. CHIEF ENGINEER: Amtrak Vice President, Chief Engineer

B. RAILROAD: National Railroad Passenger Corporation (Amtrak), and/or the duly authorized representative

C. ENGINEERING PRACTICE: Amtrak Engineering Practices establish a system of uniform practices, notices and instructions for the Amtrak Engineering Department, providing current, permanent and temporary, departmental procedures and policies.

1.4 SUBMISSION REQUIREMENTS

A. Unless otherwise directed in the Contract, the Contractor shall submit five sets of plans and calculations to the authorized representative of the Chief Engineer, Structures, whose name and address will be provided at the project pre-construction meeting.

B. Submitted calculations and plans shall be signed and sealed by a Professional Engineer, registered in the State in which the work will be performed.

C. The Contractor shall revise and resubmit plans and calculations as many times as necessary, until a complete and correct site-specific work plan for crane/ hoisting operations has been approved.

PART 2 -PRODUCTS (Not Used)

PART 3 -EXECUTION

THE CONTRACTOR SHALL PROVIDE, AT A MINIMUM, THE FOLLOWING INFORMATION FOR REVIEW AND APPROVAL BY AMTRAK ENGINEERING STRUCTURES:

A. Plan view showing location(s) of cranes, operating radii, with delivery and/or disposal locations shown. Provide all necessary dimensions for locating the elements ofthe plan.

B. Plans and computations showing the weight ofthe pick.

C. Crane rating sheets, demonstrating that cranes are adequate for 150% of the calculated pick weight. That is, the cranes shall be capable of picking 150% of the load, while maintaining normal, recommended factors of safety. The adequacy of the crane for the proposed pick shall be determined by using the manufacturer's published crane rating chart and not the maximum crane capacity. Crane and boom nomenclature is to be indicated.

D. Calculations demonstrating that slings, shackles, lifting beams, etc. are adequate for 150% of the calculated pick weight.

E. Location plan showing obstructions, indicating that the proposed swing is possible. "Walking" of load using two cranes will not be permitted. Rather, multiple picks and repositioning of the crane may be permitted to get the load to the needed location for the final pick, if necessary.

F. Data sheet listing types and sizes of slings and other connecting equipment. Include copies of catalog cuts for specialized equipment. Detail attachment methods on the plans.

G. A complete procedure, indicating the order of lifts and any repositioning or re-hitching of the crane or cranes.

H. Temporary support of any components or intermediate stages, as may be required.

I. A time schedule of the various stages, as well as a schedule for the entire lifting process.

END OF SECTION 01142A

SECTION 01520A – REQUIREMENTS FOR TEMPORARY PROTECTION SHIELDS FOR DEMOLITION AND CONSTRUCTION OF OVERHEAD BRIDGES AND OTHER STRUCTURES

PART 1 – GENERAL

1.1 SCOPE

A. This specification describes items to be included in the design and construction of temporary protection shields for construction overhead and near to Amtrak tracks.

B. Use of this specification is as required by Amtrak, as described in Amtrak Engineering Practice EP3014.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. CHIEF ENGINEER: Amtrak Vice President, Chief Engineer

B. RAILROAD: National Railroad Passenger Corporation (Amtrak), and/or the duly authorized representative

C. ENGINEERING PRACTICE: Amtrak Engineering Practices establish a system of uniform practices, notices and instructions for the Amtrak Engineering Department, providing current, permanent and temporary, departmental procedures and policies.

1.4 SUBMISSION REQUIREMENTS

A. Unless otherwise directed in the Contract, the Contractor shall submit five sets of plans and calculations to the authorized representative of the Chief Engineer, Structures, whose name and address will be provided at the project pre-construction meeting.

B. Submitted calculations and plans shall be signed and sealed by a Professional Engineer, registered in the State in which the work will be performed.

C. The Contractor shall revise and resubmit plans and calculations as many times as necessary, until a complete and correct site-specific work plan for crane/hoisting operations has been approved.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 CONTRACTORS WORKING ON OVERHEAD OR NEARBY DEMOLITION AND/OR CONSTRUCTION ADJACENT TO AMTRAK TRACKS, SHALL CONFORM TO THE FOLLOWING

3.2 DESIGN AND CONSTRUCTION REQUIREMENTS FOR TEMPORARY PROTECTION SHIELDING:

A. The Contractor shall maintain a specified level of protection to railroad facilities, during demolition and construction activities that occur overhead and nearby Amtrak tracks, as shown on the Contract Plans, as detailed in the Contract Specifications, and a described below.

B. Prior to the start of construction, the Contractor shall submit to Amtrak for review and approval, detailed site specific plans for temporary protection shields. The plans will be reviewed as to the methods of erection, and as to whether or not the proposed installation will provide the required level of protection. No construction shall proceed until the Contractor has received written approval of the Contractor's complete, site specific plans, from Amtrak.

C. The Contractor shall design the protection shields to conform to all applicable and governing federal, state and local laws and regulations.

D. Drawings for the proposed temporary protection shields shall be signed and sealed by a Licensed Professional Engineer. Complete design calculations, clearly referenced to the drawings, and easy to review, shall be provided with submission of drawings.

E. Protection shields shall be designed for the following, minimum load and size criteria.

1. The horizontal shield design live load on horizontal surfaces shall be the greater of a minimum of 100 pounds per square foot (psf) [5000 Pascals] or the anticipated live load to be produced by the Contractor's anticipated operations. When determining the appropriate design live load, the designer shall consider factors such as the physical capacity of proposed debris-catching platforms to retain materials, and the type of equipment the platforms might support. Positive means of demolition and construction controls shall be provided to assure that debris that may collect on the shield will not exceed the design live load. The horizontal protection shield, in plan view, shall cover no less than the area directly over the tracks plus ten feet minimum beyond the centerline of the outermost tracks.
2. The vertical shield shall be designed to carry a minimum 30 psf [1500 Pascals] allowance for wind load. The vertical shield shall extend a minimum of 6'-6" [1950 millimeters] above the top of the adjacent surface, such as curb or sidewalk. Anti-climb wings shall be installed at each end, as necessary, to restrict access to the railroad property.

F. The vertical and horizontal clearance envelopes required for maintenance of railroad operations, shall be indicated on the site specific work plans. These clearances are subject to review and approval by Amtrak. If applicable, both temporary and permanent envelopes shall be indicated on the plans. The temporary protection shields shall be installed outside the limits of these minimum vertical and horizontal clearances shown on the site specific work plans.

G. In electrified territory, temporary protection shields shall be bonded and grounded.

H. Temporary protection shields shall be designed and constructed to prevent dust, debris, concrete, formwork, paint, tools, or anything else from falling onto the railroad property below.

I. The temporary protection shields shall be attached to the structure in accordance with site specific work plans submitted by the Contractor and approved by Amtrak. Drilling in structural members and welding will generally not be permitted in members that are scheduled to remain in place in the reconstructed structure. For existing members scheduled for demolition or for later reconstruction, any proposed attachment shall be designed with consideration of potential existing, deteriorated conditions.

J. The Contractor shall provide the Amtrak on-site representative, for review and approval prior to any construction activity in the effected area, a proposed construction schedule for the installation, maintenance and removal of the temporary protection shields.

K. The temporary protection shields shall be installed prior to the start of any other work over the railroad in the effected areas. No construction shall proceed until the Amtrak on-site representative reviews and approves the Contractor's installed protection. Before proceeding with the work, Amtrak must be satisfied, in its sole judgement, that sufficient protection has been provided to proceed with the work.

L. The Contractor shall install and remove temporary protection shields only when an Amtrak representative is on-site.

M. The Contractor shall not install or remove temporary protection shields during train operations.

N. Temporary protection shields shall remain in place for the duration of construction activities over and nearby the railroad in the effected areas. The Contractor may remove temporary construction only after approved by Amtrak on-site representatives.

O. Where site specific conditions impose insurmountable restrictions to the design of temporary construction conforming to the limitations listed above, the design of temporary construction shall be developed in close coordination with Amtrak design review personnel. The Chief Engineer, Structures shall Provide final approval of temporary construction that does not conform to the above limitations.

END OF SECTION 01520A

SECTION 02261A – REQUIREMENTS FOR TEMPORARY SHEETING AND SHORING TO SUPPORT AMTRAK TRACKS

PART1-GENERAL

1.1 SCOPE

A. This engineering practice describes items to be included in the design and construction of temporary sheeting and shoring construction adjacent and proximate to Amtrak tracks.

B. Use of this specification is as required by Amtrak, as described in Amtrak Engineering Practice EP3014.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. CHIEF ENGINEER: Amtrak Vice President, Chief Engineer

B. RAILROAD: National Railroad Passenger Corporation (Amtrak), and/or the duly authorized representative.

C. ENGINEERING PRACTICE: Amtrak Engineering Practices establish a system of uniform practices, notices and instructions for the Amtrak Engineering Department, providing current, permanent and temporary, departmental procedures and policies.

1.4 SUBMISSION REQUIREMENTS

A. Unless otherwise directed in the Contract, the Contractor shall submit five sets of plans and calculations to the authorized representative of the Chief Engineer, Structures, whose name and address will be provided at the project pre-construction meeting.

B. Submitted calculations and plans shall be signed and sealed by a Professional Engineer, registered in the State in which the work will be performed.

C. The Contractor shall revise and resubmit plans and calculations as many times as necessary, until a complete and correct site-specific work plan for temporary sheeting and shoring has been approved.

PART 2 -PRODUCTS (Not Used)

PART 3 -EXECUTION

3.1 CONTRACTORS INSTALLING TEMPORARY CONSTRUCTION SHEETING AND SHORING TO SUPPORT AMTRAK TRACKS SHALL CONFORM TO THE FOLLOWING :

A. Footings for all piers, columns, walls, or other facilities shall be located and designed so that any temporary sheeting and shoring for support of adjacent track or tracks during construction will not be closer than toe of ballast slope. The dimension from gage of rail to toe of ballast, along tangent track, is 7'-5"; see dimensions on Track standard plans for curved track dimensions.

B. USE OF SHEETING: When support of track or tracks is necessary during construction of the above-mentioned facilities, interlocking steel sheeting, adequately braced and designed to carry Cooper E80 live-load plus 50 percent impact allowance is required. Soldier piles and lagging will be permitted for track support ONLY when required penetration of steel sheet piling cannot be obtained, due to site-specific conditions that make steel sheet piling placement impracticable, in the opinion of the authorized, Amtrak design review engineer.
   1. For usual soil conditions and limited excavations, sheeting is required when the near-track excavation extends beneath or nearer to the track than the Theoretical Railroad Embankment Line. The Theoretical Railroad Embankment Line is defined as a line that starts at grade, ten foot from the centerline of the outer track, and extends downward, away from the track, at a slope of 1-1/2 horizontal to one vertical.
   2. For special soil conditions, such as soft organic soils and rock conditions, and for unusual excavation conditions, temporary supports for excavations may be necessary even when the limits fall beyond the Theoretical Railroad Embankment Line, requiring site specific analysis by a professional, geotechnical engineer.
   3. See Sketch SK-l, "Normal Requirements for Sheet Piling Adjacent to Tracks".

C. Exploratory trenches, three feet deep and 15 inches wide in the form of an "H", with outside dimensions matching the proposed outside dimensions of sheeting, shall be hand dug, prior to placing and driving the sheeting, in any area where railroad or utility underground installations are known or suspected. These trenches are for exploratory purposes only, and shall be backfilled and immediately compacted, in layers. This work shall be performed only in the presence of a railroad inspector.

D. Absolute use of track is required while driving sheeting adjacent to running track. Track usage shall be prearranged per standard procedures, through the Amtrak project representative.

E. Cavities adjacent to sheet piling, created by pile driving, shall be filled with sand, and any disturbed ballast shall be restored and tamped immediately.

F. Sheet piling cutoffs
   1. During construction, sheeting shall be cut off at an elevation no higher than the top of tie.
   2. At the completion of construction activities involving the use of sheet piling, sheet piling may be pulled if there will be no adverse impact to the railroad track support bed, as determined by the Amtrak site engineer. This will generally be permitted when both of these conditions are met:
      a. the sheeting face is at least ten feet distant from the centerline of track, and

b. the bottom of the excavation that the sheeting supported prior to backfilling, does not fall within an assumed influence zone under the tracks. The assumed influence zone is defined as the area, as seen in cross-sectional view, falling beneath the Theoretical Underground Track Disturbance Line. This line is defined as a line that starts at the end and bottom of the ties, and extends from the track outward and downward at a one-to-one (45-degree) slope.

3. Sheet piling that is to be left in-place, shall be cut off below the ground line
   a. at least eighteen inches below final ground line at the sheeting, and
   b. no higher than 24 inches below the elevation of the bottom of the nearest ties
4. See Sketch SK-l, "Normal Requirements for Sheet Piling Adjacent to Tracks".

G. The excavation adjacent to the track shall be covered, ramped and protected by handrails, barricades and warning lights, as required by applicable safety regulations, and as directed by Amtrak.

H. Final backfilling of excavation shall conform to project specifications.

I. The Contractor shall provide Amtrak with a detailed schedule of proposed construction operations, detailing each step of the proposed temporary construction operations in proximity to Amtrak tracks, so that Amtrak may review and approve the proposed operations, and may properly inspect and monitor operations.

J. Drawings for the proposed temporary sheeting and shoring shall be signed and sealed by a Licensed Professional Engineer. Complete design calculations, clearly referenced to the drawings, and easy to review, shall be provided with submission of drawings.

K. Where site specific conditions impose insurmountable restrictions to the design of temporary construction conforming to the limitations listed above, the design of temporary construction shall be developed in close coordination with Amtrak design review personnel. The Chief Engineer, Structures shall provide final approval of temporary construction that does not conform to the above limitations.

1. When Amtrak grants approval for sheeting closer than standard minimum clearances, the Contractor shall develop a survey plan, if not already required by the project, for the adjacent tracks, to be conducted prior to, during, and after the temporary sheeting construction operations. If settlement is detected, construction operations shall be suspended until the track has been returned to its initial condition, and stabilized, as determined by the Amtrak project site representative.
2. The Contractor shall stockpile ten (10) tons of approved ballast at the project site, and maintain that amount in ready reserve, to allow for the possible need to restore track profile.

L. Particular care shall be taken in the planning, design and execution of temporary construction, as relates to railroad slope protection and drainage facilities. Erosion and sediment control best management practices shall be designed and employed, as approved by Amtrak. Any unintended disruption to railroad drainage facilities, caused by the temporary construction, shall be promptly remedied, as directed by the Engineer, solely at the Contractor's cost.

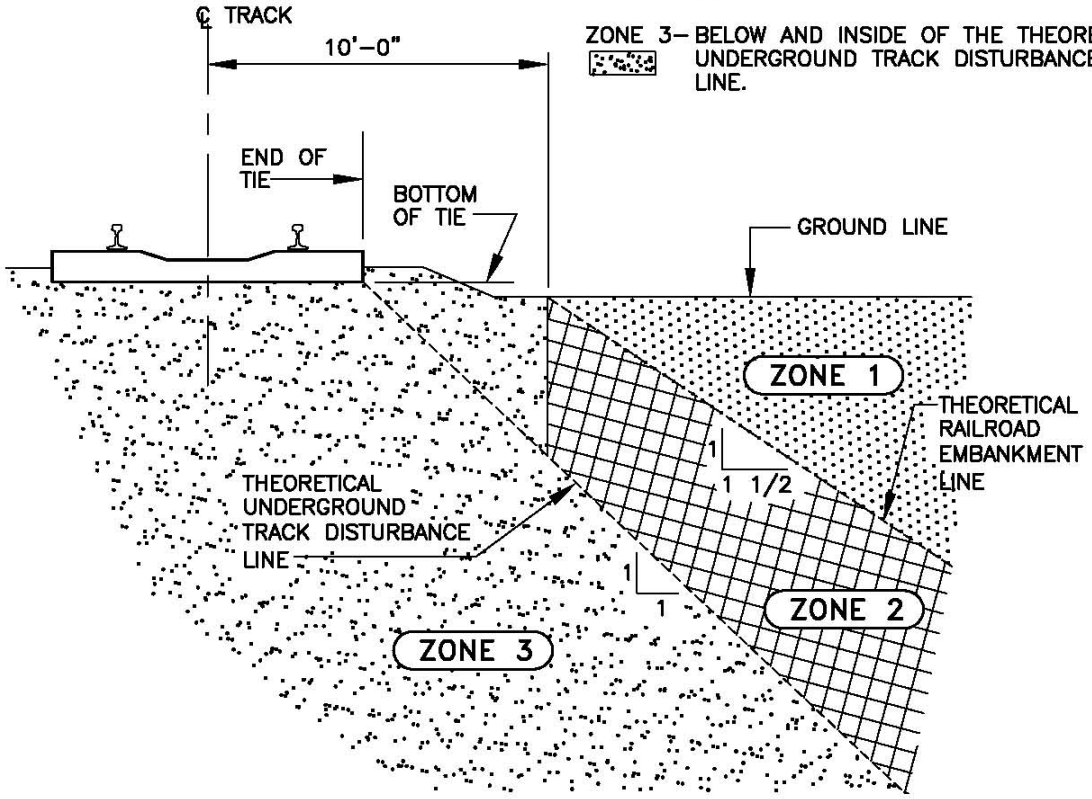
M. The following Information Sketch is attached:

LEGEND

ZONE 1 – ABOVE AND OUTSIDE THE THEORETICAL RAILROAD EMBANKMENT LINE.

ZONE 2 – FARTHER THAN 10 FEET FROM THE CENTERLINE OF TRACK, BELOW THE THEORETICAL RAILROAD EMBANKMENT LINE AND ABOVE THE THEORETICAL UNDERGROUND TRACK DISTURBANCE LINE.

ZONE 3 – BELOW AND INSIDE OF THE THEORETICAL UNDERGROUND TRACK DISTURBANCE LINE.



NORMAL REQUIREMENTS FOR SHEET PILING ADJACENT TO TRACK

① EXCAVATIONS WITHIN ZONE 1 – ABOVE AND OUTSIDE OF THE THEORETICAL RAILROAD EMBANKMENT LINE – DO NOT NORMALLY REQUIRE SHEETING TO PROTECT RAILROAD ROAD BED. SHEETING MAY BE REQUIRED FOR OTHER REASONS.

② EXCAVATIONS WHOSE BOTTOMS EXTEND INTO ZONE 2 REQUIRE SHEETING, BUT THE SHEETING MAY NORMALLY BE PULLED AFTER THE EXCAVATION HAS BEEN BACKFILLED.

③ EXCAVATIONS WHOSE BOTTOMS EXTEND INTO ZONE 3 WILL NORMALLY REQUIRE THE SHEETING TO BE LEFT IN PLACE AND CUT–OFF PER REQUIREMENTS.

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Office of Chief Engineer
STRUCTURES
National Railroad Passenger Corporation
30th Street Station, Philadelphia, Pennsylvania 19104

SKETCH 1
SPEC. 02261A – REV. 1

Designed	Drawn	Date
CJR	JLM	6/06/01

File No:	
Design No:	3501
Sheet No.	1 of 1
Dwg. No.	SK–1

END OF SECTION 02261A

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Suspended slabs.

B. Related Sections:

1. Section 035300 "Concrete Topping" for microsilica concrete topping.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect.

F. Samples: For vapor retarder.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer, manufacturer, testing agency, and professional engineer.

C. Welding certificates.

D. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Curing compounds.
5. Floor and slab treatments.
6. Vapor retarders.
7. Joint-filler strips.
8. Repair materials.

E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

G. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer in accordance with Form 816 Article 1.20-1.06.01

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete subcontractor.
e. Special concrete finish subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

C. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. Structural 1, B-B or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

B. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

2.4 REINFORCEMENT ACCESSORIES

A. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.

B. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.5 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I or Type III, gray. ASTM C 150, Type II for concrete in contact with the earth.

B. Silica Fume: ASTM C 1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
2. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

2.7 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Greenstreak Group, Inc.
   b. Williams Products, Inc.
   c. West American Rubber Company, LLC.

2. Profile: Ribbed with center bulb.
3. Dimensions: As indicated.

2.8 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class C. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Fortifiber Building Systems Group; Moistop Ultra 6.
   b. Raven Industries Inc.; Vapor Block 6.
   c. Stego Industries, LLC; Stego Wrap, 10 mil Class C.

B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.9 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not

less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing No. 8 sieve.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Anti-Hydro International, Inc.; Emery Non-Slip.
    b. Dayton Superior Corporation; Emery Tuff Non-Slip.
    c. L&M Construction Chemicals, Inc.; Grip It.

2.10 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Construction Chemicals - Building Systems; Confilm.
    b. Dayton Superior Corporation; Aquafilm (J-74).
    c. Euclid Chemical Company (The), an RPM company; Eucobar.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Construction Chemicals - Building Systems; Kure-N-Seal WB.
    b. Dayton Superior Corporation; Cure and Seal 309 (J-18).
    c. Euclid Chemical Company (The), an RPM company; Aqua Cure VOX.

2.11 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.12 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.13 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Silica Fume: 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use high-range water-reducing admixture in concrete, as required, for placement and workability.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings and Foundation Walls: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

3. Slump Limit: 8 inches for concrete with verified slump of 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

B. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Minimum Cementitious Materials Content: 540 lb/cu. yd..
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

C. Suspended Slabs: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Minimum Cementitious Materials Content: 540 lb/cu. yd..
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.15 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class B, 1/4 inch for smooth-formed finished surfaces.
2. Class C, 1/2 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50

deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Granular Course: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.

3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing or 6" (whichever is greater). Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
4. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints at intervals not greater than 32 feet, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.8 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.9 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 FINISHING FLOORS AND SLABS

A. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish.

B. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with paint or another thin-film-finish coating system.
2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:

    a. Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24 at exposed to view areas.

C. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

D. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated. Apply according to manufacturer's written instructions and as follows:

1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
2. After broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on the Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around.

Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one laboratory-cured specimen at 7 days and two specimens at 28 days. Hold last specimen for possible 56 day test.

    a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
8. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION 033000

SECTION 034100 - PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Precast structural concrete.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for placing connection anchors in concrete.
2. Section 035300 "Concrete Topping" for microsilica concrete topping.
3. Section 051200 "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Design Mixtures: For each precast concrete mixture. Include compressive strength and, if required, water-absorption tests.

D. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
4. Indicate type, size, and length of welded connections by AWS standard symbols.
5. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
6. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
7. Include and locate openings larger than 10 inches.
8. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
9. Indicate relationship of precast structural concrete units to adjacent materials.
10. Indicate estimated camber for precast floor slabs with concrete toppings.
11. Indicate shim sizes and grouting sequence.
12. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

E. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Show precast structural concrete unit types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer, fabricator, testing agency, and professional engineer.

C. Welding certificates.

D. Material Certificates: For the following:

1. Cementitious materials.
2. Reinforcing materials.
3. Admixtures.
4. Bearing pads.

E. Material Test Reports: For aggregates, by a qualified testing agency.

F. Source quality-control reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as a PCI-certified plant as follows:

a. Group C, Category C1 - Precast Concrete Products (no prestressed reinforcement).

B. Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance, to erect Category S1 - Simple Structural Systems.

C. Installer Qualifications: An experienced precast concrete erector who has retained a "PCI-Certified Field Auditor" to conduct a field audit of a project installed by erector in Category S1 - Simple Structural Systems and who can produce an Erectors' Post Audit Declaration, according to PCI MNL 127, "PCI Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products."

D. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

E. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

F. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.7 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
2. Place adequate dunnage of even thickness between each unit.
3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

D. Lift and support units only at designated points indicated on Shop Drawings.

E. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer licensed in the State of Connecticut to design precast structural concrete units.

B. Design Standards: Comply with ACI 318 and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

C. Structural Performance: Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

1. Concrete Topping Load: 50 psf.
2. Live Loads: 150 psf.
3. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318.

    a. Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of minus 30 to plus 120 deg F.

2.3 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

2.4 REINFORCING MATERIALS

A. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 775/A 775M epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

B. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

C. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.5 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray, unless otherwise indicated.

1. For surfaces exposed to view in finished structure, white cement, of same type, brand, and mill source.

B. Supplementary Cementitious Materials:
1. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33/C 33M, with coarse aggregates complying with Class 4S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

D. Coloring Admixture: ASTM C 979/C 979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading. The color of the precast ramps shall match the color of the cast in place concrete as closely as possible.

E. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

G. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.10 percent chloride ions or other salts by weight of admixture.
1. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
2. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

2.6 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.

B. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563; and flat, unhardened steel washers, ASTM F 844.

C. Welding Electrodes: Comply with AWS standards.

D. Precast Accessories: Provide steel shims and other accessories required to install precast structural concrete units.

2.7 STAINLESS-STEEL CONNECTION MATERIALS

A. Stainless-Steel Bolts and Studs: ASTM F 593, Alloy Group 1 or 2, hex-head bolts and studs; ASTM F 594, Alloy Group 1 or 2 stainless-steel nuts; and flat, stainless-steel washers.

1. Lubricate threaded parts of stainless-steel bolts with an antiseize thread lubricant during assembly.

2.8 BEARING PADS

A. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D 2240; minimum tensile strength 2250 psi, ASTM D 412.

2.9 GROUT MATERIALS

A. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.

2.10 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.
1. Limit use of silica fume to 10 percent of portland cement by weight.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 116 when tested according to ASTM C 1218/C 1218M.

D. Normal-Weight Concrete Mixtures: Proportion full-depth mixture by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.

F. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

G. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.11 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement by release agent.

B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Edge and Corner Treatment: Uniformly as indicated.

2.12 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings without Architect's approval.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds

limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.

2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel to maintain at least 5/8-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing or 6" (whichever is greater) and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

H. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

I. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

J. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

K. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

L. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

M. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Architect's approval.

2.13 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

2.14 COMMERCIAL FINISHES

A. Commercial Grade: Remove fins and protrusions larger than 1/8 inch and fill holes larger than 1/2 inch. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to 3/16 inch.

B. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.

C. Apply roughened surface finish according to ACI 318 to precast concrete units that receive concrete topping after installation.

2.15 SOURCE QUALITY CONTROL

A. Testing Agency: Owner may engage a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

B. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements and ASTM C 1610/C 1610M, ASTM C 1611/C 1611M, ASTM C 1621/C 1621M, and ASTM C 1712/C 1712M.

C. Strength of precast structural concrete units is considered deficient if units fail to comply with ACI 318 requirements for concrete strength.

D. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.

1. A minimum of three representative cores shall be taken from units of suspect strength, from locations directed by Architect.
2. Test cores in an air-dry condition or, if units are wet under service conditions, test cores after immersion in water in a wet condition.
3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Report test results in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.

e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

3.2 INSTALLATION

A. Install bearing pads and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Install temporary steel spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

D. Field cutting of precast units is not permitted without approval of Architect.

E. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780/A 780M.
3. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
4. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

F. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
2. For slip-critical connections, use one of the following methods to assure proper bolt pretension:

    a. Turn-of-Nut: According to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
    b. Calibrated Wrench: According to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
    c. Twist-off Tension Control Bolt: ASTM F 1852.
    d. Direct-Tension Control Bolt: ASTM F 1852.

3. For slip-critical connections, use method and inspection procedure approved by Architect and coordinated with inspection agency.

G. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

1. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces.
2. Fill joints completely without seepage to other surfaces.
3. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
4. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Architect.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Erection of precast structural concrete members.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Visually inspect field welds and test according to ASTM E 165 or to ASTM E 709 and ASTM E 1444. High-strength bolted connections are subject to inspections.

D. Testing agency will report test results promptly and in writing to Contractor and Architect.

E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

G. Prepare test and inspection reports.

3.5 REPAIRS

A. Repair precast structural concrete units if permitted by Architect.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

3.6 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100

SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Architectural precast concrete cladding units.
2. Thin-brick-faced, architectural precast concrete units.

B. Related Sections:
1. Section 042113 “Unit Masonry” for matching modular brick.
2. Section 047200 "Cast Stone Masonry" for wet- or dry-cast cast stone facings, trim, and accessories.
3. Section 051200 "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.
4. Section 055000 "Metal Fabrications" for kickers and other miscellaneous steel shapes.

1.3 DEFINITIONS

A. Design Reference Sample: Sample of approved architectural precast concrete color, finish and texture, preapproved by Architect.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.5 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.

D. Shop Drawings:

1. Detail fabrication and installation of architectural precast concrete units.
2. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
4. Indicate details at building corners.
5. Indicate type, size, and length of welded connections by AWS standard symbols. Detail loose and cast-in hardware and connections.
6. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
7. Indicate locations, extent, and treatment of dry joints if two-stage casting is proposed.
8. Include plans and elevations showing unit location and sequence of erection for special conditions.
9. Indicate location of each architectural precast concrete unit by same identification mark placed on panel.
10. Indicate relationship of architectural precast concrete units to adjacent materials.
11. Indicate locations, dimensions, and details of thin-brick units, including corner units and special shapes, and joint treatment.
12. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

E. Samples: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.

1. When other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.
2. Samples for each thin-brick unit required, showing full range of color and texture expected. Include Sample showing color and texture of joint treatment.

    a. Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing manufacturer's full range of colors.
    b. Grout Samples for Verification: Showing color and texture of joint treatment.

F. Delegated-Design Submittal: For architectural precast concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Show governing panel types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from architectural precast concrete.

1.6 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer fabricator] testing agency and professional engineer.

C. Welding certificates.

D. Material Certificates: For the following items:

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Thin-brick units and accessories.

E. Material Test Reports: For aggregates.

F. Preconstruction test reports.

G. Source quality-control test reports.

H. Field quality-control and special inspection reports.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance to erect Category A (Architectural Systems) for non-load.

C. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as a PCI-certified plant for Group A, Category A1 - Architectural Cladding and Load Bearing Units at time of bidding.

D. Testing Agency Qualifications: An independent testing agency[acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

E. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."

F. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D.1.1M, "Structural Welding Code - Steel"; and AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

G. Sample Panels: After sample approval and before fabricating architectural precast concrete units, produce a minimum of two sample panels approximately 16 sq. ft. in area for review by Architect. Incorporate full-scale details of architectural features, finishes (including thin-brick masonry), textures, and transitions in sample panels.

1. Locate panels as directed by Architect.

H. Range Samples: After sample panel approval and before fabricating architectural precast concrete units, produce a minimum of three sets of samples, approximately 8 sq. ft. in area, representing anticipated range of each color and texture on Project's units. Maintain one set of range samples at Project site and remaining range sample sets at manufacturer's plant as color and texture approval reference.

1.8 COORDINATION & SEQUENCING

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction (such as steel structure and concrete masonry back-up wall) without delaying the Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground or other rehandling.

C. Support units during shipment on nonstaining shock-absorbing material.

D. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

E. Place stored units so identification marks are clearly visible, and units can be inspected.

F. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

G. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design architectural precast concrete units.

B. Design Standards: Comply with ACI 318 and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.

C. Structural Performance: Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:

1. Loads: As indicated.
2. Design precast concrete units and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements as follows:

3. Thermal Movements: Provide for in-plane thermal movements resulting from annual ambient temperature changes of 80 deg F

2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

B. Form Liners: Units of face design, texture, arrangement, and configuration indicated to match those used for precast concrete design reference sample. Use with manufacturer's recommended form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Reinforcement: Deformed steel bars complying with ASTM A 615/A 615M, Grade 60. Use epoxy-coated reinforcement.

1. Epoxy Coating: ASTM A 775/A 775M.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from wire into flat sheets.

E. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray, unless otherwise indicated.

1. For surfaces exposed to view in finished structure, white cement, of same type, brand, and mill source.

B. Supplementary Cementitious Materials:
1. Metakaolin: ASTM C 618, Class N.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33/C 33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.

a. Gradation: Uniformly graded**.**

2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate; to match approved finish sample.

D. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C 330/C 330M, with absorption less than 11 percent.

E. Coloring Admixture: ASTM C 979/C 979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading. Refer to Architect's sample for color to match at exposed precast.

F. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

G. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

H. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
1. Retarding Admixture: ASTM C 494/C 494M, Type B.
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

2.5 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.

B. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or Type B, with arc shields and with minimum mechanical properties of PCI MNL 117, Table 3.2.3.

C. High-Strength Bolts and Nuts: ASTM A 325, Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563; and hardened carbon-steel washers, ASTM F 436.

D. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M or ASTM A 153/A 153M..

1. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
2. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.

E. Shop-Primed Finish: Prepare surfaces of nongalvanized steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3 and shop-apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 according to SSPC-PA 1.

F. Welding Electrodes: Comply with AWS standards.

2.6 STAINLESS-STEEL CONNECTION MATERIALS

A. Stainless-Steel Plate: ASTM A 666, Type 304, Type 316, or Type 201.

B. Stainless-Steel Bolts and Studs: ASTM F 593, Alloy Group 1 or 2 hex-head bolts and studs; ASTM F 594, Alloy Group 1 or 2 stainless-steel nuts; and flat, stainless-steel washers.

1. Lubricate threaded parts of stainless-steel bolts with an antiseize thread lubricant during assembly.

C. Stainless-Steel-Headed Studs: ASTM A 276, Alloy 304 or Alloy 316, with minimum mechanical properties of PCI MNL 117, Table 3.2.3.

2.7 BEARING PADS

A. Provide one of the following bearing pads for architectural precast concrete units as recommended by precast fabricator for application:

1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, Type A durometer hardness of 50 to 70, ASTM D 2240, minimum tensile strength 2250 psi, ASTM D 412.

2. Random-Oriented-Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. Type A durometer hardness of 70 to 90, ASTM D 2240; capable of supporting a compressive stress of 3000 psi with no cracking, splitting, or delaminating in the internal portions of pad. Test one specimen for every 200 pads used in Project.
3. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; Type A durometer hardness of 80 to 100, ASTM D 2240; complying with AASHTO's "AASHTO LRFD Bridge Design Specifications," Division II, Section 18.10.2; or with MIL-C-882E.
4. Frictionless Pads: PTFE, glass-fiber reinforced, bonded to stainless or mild-steel plate, or random-oriented-fiber-reinforced elastomeric pads; of type required for in-service stress.
5. High-Density Plastic: Multimonomer, nonleaching, plastic strip.

2.8 ACCESSORIES

A. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install architectural precast concrete units.

2.9 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C 150/C 150M, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.

B. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

2.10 THIN BRICK AND ACCESSORIES

A. Basis of Design Product: Subject to compliance with requirements, provide Albany, by Glen Gery or approved equal.

B. Thin Brick: Not less than 1/2 inch thick, and as follows:

1. Dimensional Tolerances: Plus 0 inch or minus 1/16 inch for any dimension 8 inches or less and plus 0 inch or minus 3/32 inch for any dimension more than 8 inches.
2. Cold Water Absorption at 24 hours: Maximum 6% when tested in accordance with ASTM C 67.
3. Out-of-Square Tolerance: Plus or minus 1/16 inch.
4. Warpage Tolerance: Plus 0 inch or minus 1/16 inch.
5. Variation of Shape from Specified Angle: Plus or minus one degree.
6. Modulus of Rupture: Not less than 250 psi when tested according to ASTM C 67.

7. Tensile Bond Strength: Not less than 150 psi when tested before and after freeze-thaw test according to ASTM E 488 as modified: Adhere a steel plate with a welded rod on a single thin-brick face with epoxy for each test.
8. 24-Hour Cold-Water Absorption: Not more than 6 percent when tested according to ASTM C 67.
9. Freeze-Thaw Resistance: No detectable disintegration or separation after 300 freezing-and-thawing cycles when tested according to ASTM C 666/C 666M, Method B.
10. Modulus of Rupture: Not less than 250 psi (1.7 MPa) when tested in accordance with ASTM C 67.
11. Chemical Resistance: Tested according to ASTM C 650 and rated "not affected."
12. Efflorescence: Tested according to ASTM C 67 and rated "not effloresced."
13. Surface Coloring: Brick with surface coloring shall withstand 50 cycles of freezing and thawing per ASTM C 67 with no observable difference in applied finish when viewed from 20 ft (6 m).
14.

C. Special Shapes: Include corners, edge corners, and end edge corners. No mitered outside and inside corners will be accepted. Appearance must be identical to modular brick units.

D. Face Size: 2-1/4 inches high by 7-5/8 inches long.

E. Sand-Cement Mortar: Portland cement, ASTM C 150/C 150M, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.

F. Pointing Grout: Packaged, polymer-modified, sanded grout complying with ANSI A118.7.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

a. Bostik, Inc.
b. DAP Products Inc.
c. Laticrete International, Inc.
d. MAPEI Corporation.
e. TEC Specialty Products Inc.

2. Colors: As indicated on drawings.

2.11 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Use a single design mixture for units with more than one major face or edge exposed.
2. Where only one face of unit is exposed use either a single design mixture or separate mixtures for face and backup.

B. Limit use of metakaolinto 10 percent of portland cement by weight.Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 117 when tested according to ASTM C 1218/C 1218M.

D. Normal-Weight Concrete Mixtures: Proportion face and backup mixturesby either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi minimum.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to ASTM C 642, except for boiling requirement.

F. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:

1. Compressive Strength (28 Days): 5000 psi.
2. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft., plus or minus 3 lb/cu. ft., according to ASTM C 567.

G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.

H. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

2.12 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

1. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.

B. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

1. Form joints are not permitted on faces exposed to view in the finished work.
2. Edge and Corner Treatment: Uniformly as indicated.

2.13 THIN-BRICK FACINGS

A. Place form liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.

B. Securely place thin-brick units face down into form liner pockets and place concrete backing mixture.

C. Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.

D. Mix and install pointing grout according to ANSI A108.10. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading grout onto faces of thin-brick units. Remove excess grout immediately to prevent staining of thin brick.

1. Tool joints to a slightly concaveshape when pointing grout is thumbprint hard.

E. Clean faces and joints of thin-brick facing.

2.14 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on the Contract Drawings.

D. Do not drill or cut openings or prestressing strand without Architect's approval.

E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel and prestressing strands to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Prestress tendons for architectural precast concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 117.

1. Delay detensioning or post-tensioning of precast, prestressed architectural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete unit.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat-cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

H. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

I. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.

J. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

1. Place backup concrete mixture to ensure bond with face-mixture concrete.

K. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.

1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.

L. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.

M. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that does not show in finished structure.

N. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure

units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

O. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.

2.15 FABRICATION TOLERANCES

A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

B. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with the following product tolerances:

1. Overall Height and Width of Units, Measured at the Face Exposed to View: As follows:

    a. 10 feet or under, plus or minus 1/8 inch.
    b. 10 to 20 feet, plus 1/8 inch, minus 3/16 inch.
    c. 20 to 40 feet, plus or minus 1/4 inch.
    d. Each additional 10 feet, plus or minus 1/16 inch.

2. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:

    a. 10 feet or under, plus or minus 1/4 inch.
    b. 10 to 20 feet, plus 1/4 inch, minus 3/8 inch.
    c. 20 to 40 feet, plus or minus 3/8 inch.
    d. Each additional 10 feet, plus or minus 1/8 inch.

3. Total Thickness or Flange Thickness: Plus 1/4 inch, minus 1/8 inch.
4. Rib Thickness: Plus or minus 1/8 inch.
5. Rib to Edge of Flange: Plus or minus 1/8 inch.
6. Distance between Ribs: Plus or minus 1/8 inch.
7. Variation from Square or Designated Skew (Difference in Length of the Two Diagonal Measurements): Plus or minus 1/8 inch/72 inches or 1/2 inch total, whichever is greater.
8. Length and Width of Block-outs and Openings within One Unit: Plus or minus 1/4 inch.
9. Location and Dimension of Block-outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or minus 3/4 inch.
10. Dimensions of Haunches: Plus or minus 1/4 inch.
11. Haunch Bearing Surface Deviation from Specified Plane: Plus or minus 1/8 inch.
12. Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or minus 1/4 inch.
13. Bowing: Plus or minus L/360, maximum 1 inch.
14. Local Smoothness: 1/4 inch/10 feet.
15. Warping: 1/16 inch/12 inches of distance from nearest adjacent corner.
16. Tipping and Flushness of Plates: Plus or minus 1/4 inch.
17. Dimensions of Architectural Features and Rustications: Plus or minus 1/8 inch.

C. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.

1. Weld Plates: Plus or minus 1 inch.
2. Inserts: Plus or minus 1/2 inch.
3. Handling Devices: Plus or minus 3 inches.
4. Reinforcing Steel and Welded Wire Reinforcement: Plus or minus 1/4 inch where position has structural implications or affects concrete cover; otherwise, plus or minus 1/2 inch.
5. Reinforcing Steel Extending out of Member: Plus or minus 1/2 inch of plan dimensions.
6. Tendons: Plus or minus 1/4 inch, vertical; plus or minus 1 inch, horizontal.
7. Location of Rustication Joints: Plus or minus 1/8 inch.
8. Location of Opening within Panel: Plus or minus 1/4 inch.
9. Location of Flashing Reglets: Plus or minus 1/4 inch.
10. Location of Flashing Reglets at Edge of Panel: Plus or minus 1/8 inch.
11. Reglets for Glazing Gaskets: Plus or minus 1/8 inch.
12. Electrical Outlets, Hose Bibs: Plus or minus 1/2 inch.
13. Location of Bearing Surface from End of Member: Plus or minus 1/4 inch.
14. Allowable Rotation of Plate, Channel Inserts, and Electrical Boxes: 2-degree rotation or 1/4 inch maximum over the full dimension of unit.
15. Position of Sleeve: Plus or minus 1/2 inch.

D. Thin-Brick-Faced Architectural Precast Concrete Units: Restrict the following misalignments to 2 percent of number of thin bricks in a unit.

1. Alignment of Mortar Joints:

    a. Jog in Alignment: 1/8 inch.
    b. Alignment with Panel Centerline: Plus or minus 1/8 inch.

2. Variation in Width of Exposed Mortar Joints: Plus or minus 1/8 inch.
3. Tipping of Individual Thin Bricks from the Panel Plane of Exposed Thin-Brick Surface: Plus 0 inch; minus 1/4 inch less than or equal to depth of form liner joint.
4. Exposed Thin-Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 inch; minus 1/8 inch.
5. Individual Thin-Brick Step in Face from Panel Plane of Exposed Thin-Brick Surface: Plus 0 inch; minus 1/4 inch less than or equal to depth of form liner joint.

2.16 FINISHES

A. Exposed faces shall be free of joint marks, grain, and other obvious defects. Corners, including false joints shall be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved design reference sampleand as follows:
1. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
2. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
3. Thin-Brick Facing: See "Thin-Brick Facings" Article.

B. Finish exposed top**bottom** surfaces of architectural precast concrete units to match face-surface finish.

C. Finish exposed back surfaces of architectural precast concrete units with smooth, steel-trowel finish.

D. Finish unexposed surfaces of architectural precast concrete units by float finish

2.17 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6, ASTM C 1610/C 1610M, ASTM C 1611/C 1611M, ASTM C 1621/C 1621M, and ASTM C 1712.

B. Owner may employ an independent testing agency to evaluate architectural precast concrete fabricator's quality-control and testing methods.

1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

C. Strength of precast concrete units is considered deficient if units fail to comply with ACI 318 requirements for concrete strength.

D. Testing: If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 requirements, precaster will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M and ACI 318.

1. A minimum of three representative cores shall be taken from units of suspect strength, from locations directed by Architect.
2. Test cores in an air-dry condition.
3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Report test results in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace recast architectural concrete units that do not comply with acceptability requirements in PCI MNL 117, including concrete strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Do not install precast concrete units until supporting cast-in-place concrete has attained minimum allowable design compressive strength and supporting steel or other structure is structurally ready to receive loads from precast concrete units.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.

B. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

1. Install temporary steel or plastic spacing shims as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
4. Unless otherwise indicated, maintain uniform joint widths of 3/4 inch.

C. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

1. Do not permit connections to disrupt continuity of roof flashing.

D. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Welds not specified shall be continuous fillet welds, using no less than the minimum fillet as specified by AWS.
3. Clean weld-affected metal surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780/A 780M.
4. Clean weld-affected metal surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
5. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

E. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.

F. Grouting or Dry-Packing Connections and Joints: Grout connections where required or indicated. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

B. Erect architectural precast concrete units level, plumb, square, and in alignment, without exceeding the following noncumulative erection tolerances:

1. Plan Location from Building Grid Datum: Plus or minus 1/2 inch.
2. Plan Location from Centerline of Steel: Plus or minus 1/2 inch.
3. Top Elevation from Nominal Top Elevation: As follows:

    a. Exposed Individual Panel: Plus or minus 1/4 inch.
    b. Non-Exposed Individual Panel: Plus or minus 1/2 inch.
    c. Exposed Panel Relative to Adjacent Panel: 1/4 inch.
    d. Non-Exposed Panel Relative to Adjacent Panel: 1/2 inch.

4. Support Elevation from Nominal Support Elevation: As follows:

    a. Maximum Low: 1/2 inch.
    b. Maximum High: 1/4 inch.

5. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet: 1 inch.
6. Plumb in Any 10 Feet of Element Height: 1/4 inch.
7. Maximum Jog in Alignment of Matching Edges: 1/4 inch.
8. Joint Width (Governs over Joint Taper): Plus or minus 1/4 inch.
9. Maximum Joint Taper: 3/8 inch.
10. Joint Taper in 10 Feet: 1/4 inch.
11. Maximum Jog in Alignment of Matching Faces: 1/4 inch.
12. Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 1/4 inch.
13. Opening Height between Spandrels: Plus or minus 1/4 inch.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections and prepare reports:

1. Erection of loadbearing precast concrete members.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

C. Visually inspect field welds and test according to ASTM E 165 or to ASTM E 709 and ASTM E 1444. High-strength bolted connections are subject to inspections.

D. Testing agency will report test results promptly and in writing to Contractor and Architect.

E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

3.5 REPAIRS

A. Repair architectural precast concrete units if permitted by Architect. Architect reserves the right to reject repaired units that do not comply with requirements.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.6 CLEANING

A. Clean surfaces of precast concrete units exposed to view.

B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034500

SECTION 035300 - CONCRETE TOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. This Section specifies requirements for cast-in place microsilica concrete to be placed as an overlay to the precast and cast-in-place concrete platform slabs and includes the following:

1. Performance requirements for the production of high strength concrete overlay with microsilica (silica fume) admixture for the reduction of concrete permeability to protect against intrusion by chlorides and other aggressive chemicals.
2. Cleaning, surface preparation, furnishing, placing, finishing and curing of the microsilica concrete (MSC), saw cutting and installing joints, and final clean-up.
3. Microsilica concrete overlay shall be provided where indicated on the contract drawings or as directed by the Engineer.
4. Any damage to adjacent or remaining structures caused by Contractor's operations will be repaired by the contractor at his expense in a manner approved by the Engineer.

B. Related Sections:

1. Section 033000 "Cast-in-Place Concrete" for concrete slab construction and finish.
2. Section 034100 "Precast Structural Concrete" for precast concrete platform slabs.
3. Section 079200 "Joint Sealants" for joint sealants and backing rods.
4. Section 238316 "Hydronic Snow Melt System" for radiant heating piping.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Test Reports: Submit independent test data by a qualified testing agency substantiating the product's ability to reduce concrete permeability by chlorides and other aggressive chemicals.

C. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 QUALITY ASSURANCE

A. Manufacturer: Concrete admixtures shall be manufactured by a firm with a minimum of 5 years' experience in the production of similar products. Manufacturers proposed for use but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years.

B. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

C. Preinstallation Conference: A preinstallation conference shall be held two weeks prior to commencement of field operations to install the specified product in order to establish procedures, maintain optimum working conditions and coordinate this work with related and adjacent work. Agenda for meeting shall include concrete and admixture handling, placing, finishing, and curing. Conduct conference at Project site.

D. Manufacturer's Representative: A representative of the manufacturer shall be present for project start-up during initial concrete placement. Engineer may waive requirement for manufacturer's representative if Contractor provides sufficient evidence that producer and finisher have adequate experience with admixtures required.

E. Trial Mix: Provide a minimum 4 cubic yard (3 m^3) trial mix containing proposed concrete design mix placed at the job site in a location acceptable to the Engineer. Engineer may waive requirement for trial mix if Contractor provides sufficient evidence that producer and finisher have adequate experience with low water cement ratio mixes.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

B. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

C. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting concrete overlay performance.

1. Place concrete overlay only when ambient temperature and temperature of base slabs are between 50 and 86 deg F or as required by the manufacturer.

B. Close areas to traffic during topping application and, after application, for time period recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 STEEL REINFORCEMENT

A. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

B. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

2.3 REINFORCEMENT ACCESSORIES

A. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II, gray.

B. Silica Fume: ASTM C 1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

2.6 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

2.7 RELATED MATERIALS

A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Portland Cement: ASTM C 150, Type I or II.

C. Sand: ASTM C 404, fine aggregate passing No. 16 sieve.

D. Water: Potable.

E. Acrylic-Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

F. Epoxy Adhesive: ASTM C 881/C 881M, Type V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

2.8 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Silica Fume: 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use high-range water-reducing admixture in concrete, as required, for placement and workability.

2.9 CONCRETE MIXTURES FOR MICROSILICA CONCRETE OVERLAY

A. Microsilica Concrete Overlay: Proportion normal-weight concrete mixture with microsilica to meet the following performance criteria:

1. Minimum Compressive Strength: 5000 psi at 28 days.
2. Maximum Permeability: 800 coulombs at 56 days. ASTM C 31 & ASTM C 1202
3. Minimum Bond strength: 150 psi at 28 days. ASTM C1042
4. Maximum Water-Cementitious Materials Ratio: 0.40.
5. Minimum Cementitious Materials Content: 700 lb/cu. yd. for 3/4” maximum aggregate.
6. Slump Limit: 6 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
7. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.

B. Microsilica and cement are considered cementitious materials in calculations.

C. Add microsilica as a liquid slurry or in dry densified form in 25 lb Concrete Ready Bags packaging. The water content of slurry shall be included as mix design water.

D. Blended cements with interground microsilica will not be allowed.

E. Air Entrainment: For freeze-thaw durability comply with ACI 318 freezing and thawing exposure requirements, as determined by ASTM C 173 or ASTM C 281.

F. Concrete Admixtures: High-range water reducers meeting the requirements of ASTM C494, Type F are required to control slump, mixing, cementitious ratio and proper distribution of the microsilica, and shall be plant added. Additional water reducers may be added at the job site when required.

G. Additional Concrete Admixtures: Additional concrete admixtures conforming to ASTM C 494 or equivalent CSA 266 standards may be used as required.

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

A. Microsilica Concrete shall be mixed in transit mixers only in accordance with microsilica manufacturer’s written requirements.

B. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M except as noted below, and furnish batch ticket information.

C. Special Mixing Requirements for Densified Microsilica: Densified microsilica requires enhanced mixing to ensure full dispersion. The following mix requirements shall be adhered to:

1. For all types of mixing equipment, mix times shall be increased by 40% over the minimum mix time required to achieve mix uniformity as defined by ASTM C 94.
2. For truck-mixed and central mixed concrete, maximum allowable batch size shall be 80% of the maximum as called out by ASTM C 94.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of concrete floor topping.

B. Verify that base concrete slabs comply with scratch finish requirements specified in Section 033000 "Cast-in-Place Concrete."

C. Notify Engineer in writing of circumstances detrimental to the proper completion of the work.

D. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT

A. Microsilica concrete shall be mixed by transit mixers only.

B. Equipment used shall supply air and water free of oil so as not to contaminate the deck surface (i.e. equipped with oil trap).

3.3 PREPARATION

A. Existing Concrete: Remove existing surface treatments and deteriorated and unsound concrete. Ensure that base slabs exhibit a heavily scarified surface profile with an amplitude of 1/4 inch.

1. Prepare and clean existing base slabs. Fill voids, cracks, and cavities in base slabs.
2. Surface to receive MSC shall be cleaned no more than 24 hours prior to placement of overlay. The surface may require additional cleaning if placement is delayed.
3. Entire surface shall be cleaned by high-pressure water blasting or other approved method to remove any curing compound, loose concrete, laitance, oil or any other residue or contaminate that may be detrimental to achieving bond.
4. The surface shall be protected after cleaning but before placement of the MSC by covering all surfaces to receive the overlay with a minimum 6mil thick polyethylene film.
5. The concrete deck surface to receive the overlay shall be wetted for 12 hours prior to placement of the MSC or as required by the manufacturer of the bonding agent. Standing water shall be blown clear prior to placement of the overlay.

B. Install joint-filler strips where topping abuts vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with topping surface, unless otherwise indicated.
2. Terminate full-width, joint-filler strips 1/2 inch below topping surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.4 OVERLAY APPLICATION

A. Start overlay application in presence of manufacturer's technical representative.

B. Install temporary plywood planks over radiant heating piping as needed to protect piping during placement of MSC overlay.

C. Monolithic Overlay: After textured-float finish is applied to fresh concrete of base slabs specified in Section 033000 "Cast-in-Place Concrete," place MSC overlay while concrete is still plastic.

D. Deferred Overlay: Within 72 hours of placing base slabs, mix and scrub bonding slurry into dampened concrete to a thickness of 1/16 to 1/8 inch, without puddling. Place MSC overlay while slurry is still tacky.

E. Existing Concrete: Apply epoxy-bonding adhesive, mixed according to manufacturer's written instructions, and scrub into dry base slabs to a thickness of 1/16 to 1/8 inch, without puddling. Place overlay while adhesive is still tacky. All surfaces in contact with the microsilica concrete shall be evenly coated. No excess bonding adhesive shall be allowed to collect in pockets.

F. The application of bonding adhesive shall be limited to an area that can easily be covered with the MSC overlay before the adhesive begins to dry. If the Engineer determines that the bonding adhesive has dried before the application of the MSC, the contractor shall clean and re-prepare the surface as described above.

G. The MSC overlay and bonding adhesive shall not be placed in the rain.

H. Place concrete overlay continuously in a single layer, tamping and consolidating to achieve tight contact with bonding surface. Do not permit cold joints or seams to develop within pour strip.

1. Screed surface with a straightedge and strike off to correct elevations.
2. Slope surfaces uniformly where indicated.
3. Begin initial floating using bull floats to form a uniform and open-textured surface plane free of humps or hollows.

I. Concrete Cover: Minimum concrete cover over reinforcement shall be 1 1/2". Minimum concrete cover over radiant heating piping shall be 2".

J. Finishing: Underfinish microsilica concrete by limiting finishing operation to screeding, bull-float, and broom finish. Curing shall be initiated within one hour of concrete placement.
1. Finish and measure surface so gap at any point between surface and an unleveled freestanding 10-foot-long straightedge, resting on 2 high spots and placed anywhere on the surface, does not exceed 1/4 inch.

K. Expansion/Construction Joints: Construct joints true to line with faces perpendicular to surface plane of concrete overlay, at locations indicated or as approved by Architect.

L. Contraction Joints: Form weakened-plane contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete overlay when cutting action will not tear, abrade, or otherwise damage surface and before random contraction cracks develop.

1. Form joints in concrete overlay over contraction joints in base slabs, unless otherwise indicated.
2. Construct contraction joints for a depth equal to one-fourth of concrete overlay thickness, but not less than 1/2 inch deep.

3.5 PROTECTING AND CURING

A. General: Protect freshly placed concrete overlay from premature drying and excessive cold or hot temperatures.

B. Wind breaks, sun shades, and fog misting may be utilized to minimize the rate of evaporation at the concrete surface.

C. Fog misting shall be provided when the rate of evaporation at the concrete surface exceeds 0.1 pound per square foot per hour as determined by ACI 308 Section 1.2.1. Fogging shall continue after the finishing operation until prewetted burlap or other approved curing material is placed over the concrete. When fog misting is not provided, an evaporation retarder shall be applied before and after bull-floating and during final finish to protect the concrete.

D. Evaporation Retarder: Apply evaporation retarder to concrete overlay surfaces in hot, dry, or windy conditions before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating and during final finish to protect the concrete.

E. Begin curing immediately after finishing concrete overlay. Cure by one or a combination of the following methods, according to microsilica manufacturer's written instructions:

1. Moisture Curing: Keep surfaces continuously moist with water-fog spray and absorptive cover. The MSC shall be wet cured with prewetted burlap for a minimum of 7 days. The burlap shall be lapped a minimum of 12 inches and shall be protected from displacement. The burlap shall be presoaked for a minimum of 24 hours and shall be drained of excess water prior to application.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

F. Protect completed work from damage and construction operations throughout finishing and curing operations.

G. Removal of the burlap should be done late in the day so as to reduce the thermal shock to the overlay.

3.6 JOINT FILLING

A. Prepare and clean contraction joints and install joint filler, according to manufacturer's written instructions, once topping has fully cured.

3.7 REPAIRS

A. Defective Topping: Repair and patch defective concrete overlay areas, including areas that have not bonded to concrete substrate.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing and inspecting of completed applications of concrete overlays shall take place in successive stages, in areas of extent and using methods as follows:

1. Sample Sets: At point of placement, a set of 3 molded-cube samples shall be taken from the overlay mix for the first 1000 sq. ft., plus 1 set of samples for each subsequent 5000 sq. ft. of overlay, or fraction thereof, but not less than 6 samples for each day's placement. Samples shall be tested according to ASTM C 109/C 109M for compliance with compressive-strength requirements.
2. Concrete overlay shall be tested for delamination by dragging a steel chain over the surface.
3. Concrete overlay shall be tested for compliance with surface flatness and levelness tolerances.

C. Remove and replace applications of concrete overlay where test results indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION 035300

SECTION 042113 - BRICK MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:
1. Face brick.
2. Mortar and grout.
3. Ties and anchors.
4. Embedded flashing.
5. Miscellaneous masonry accessories.

B. Related Sections:
1. Section 034500 "Precast Architectural Concrete" for thin brick.
2. Section 047200 "Cast Stone Masonry" for furnishing cast stone trim.
3. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
4. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles for brick masonry.
5. Section 099610 “Graffiti Control” for application of graffiti control coatings.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

D. Samples for Initial Selection:
   1. Colored mortar.

E. Samples for Verification: For each type and color of the following:
   1. Face brick.
   2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
   3. Weep holes and vents.
   4. Accessories embedded in masonry.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

D. Material Certificates: For each type and size of the following:

   1. Masonry units.

      a. Include data on material properties.
      b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
      c. For exposed brick, include test report for efflorescence according to ASTM C 67.

   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Grout mixes. Include description of type and proportions of ingredients.
   5. Anchors, ties, and metal accessories.

E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate in accordance with Form 816 Article 1.20-1.06.01.

C. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches long by 48 inches high by full thickness.
2. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
3. Clean one-half of exposed faces of panels with masonry cleaner indicated.
4. Protect approved sample panels from the elements with weather-resistant membrane.
5. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

E. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

F. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: If indicated on drawings, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Face Brick: Facing brick complying with ASTM C 216.

1. Products: Subject to compliance with requirements, provide one of the following, or approved equal:

   a. Glen Gery Albany modular face brick, machine molded unfrogged

2. Grade: MW or SW.
3. Type: FBX or HBX
4. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C 67.
5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
6. Size (Actual Dimensions): 3-1/2 inches wide by 2-1/4 inches high by 7-1/2 inches long or 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.

2.3 MORTAR MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Capital Materials Corporation
   b. Cemex S.A.B. de C.V.
   c. Essroc, Italcementi Group

d. Holcim (US) Inc.
e. Lafarge North America Inc.
f. Lehigh Cement Company
g. National Cement Company, Inc.

E. Mortar Cement: ASTM C 1329.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Lafarge North America Inc.
b. Approved equal.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Davis Colors; True Tone Mortar Colors.
b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
c. Solomon Colors, Inc.; SGS Mortar Colors.

G. Colored Cement Product: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Colored Portland Cement-Lime Mix:

1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
3) Lafarge North America Inc.; Eaglebond Portland & Lime.
4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.

2. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
3. Pigments shall not exceed 10 percent of portland cement by weight.

H. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.

4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

2.4 REINFORCEMENT

A. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

B. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- diameter, stainless-steel continuous wire.

2.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
   1. Stainless-Steel Wire: ASTM A 580/A 580M, Type 316.
   2. Stainless-Steel Sheet: ASTM A 666, Type 316.
   3. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.

B. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.062-inch-thick, stainless-steel sheet.

C. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

   1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, stainless-steel wire.
   2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch- diameter, stainless-steel wire.

E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

   1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.109-inch- thick, stainless-steel sheet.

   2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.25-inch- diameter, stainless-steel wire.
   3. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.078-inch thick, stainless-steel sheet or 0.109-inch- thick, stainless-steel sheet with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch of masonry face.

F. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:
3. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) Dayton Superior Corporation, Dur-O-Wal Division
      2) Heckmann Building Products Inc
      3) Hohmann & Barnard, Inc
      4) Wire-Bond

2.6 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.

2.7 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
2. Copper: ASTM B 370, Temper H00, cold-rolled copper sheet, 16-oz./sq. ft. weight or 0.0216 inch thick or ASTM B 370, Temper H01, high-yield copper sheet, 12-oz./sq. ft. weight or 0.0162 inch thick.
3. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
4. Fabricate through-wall metal flashing embedded in masonry from stainless steel or copper, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) Cheney Flashing Company;

2) Keystone Flashing Company, Inc.
3) Sandell Manufacturing Co., Inc.

5. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
6. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
7. Fabricate metal drip edges for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.
8. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
9. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
10. Metal Expansion-Joint Strips: Fabricate from stainless steel or copper to shapes indicated.

B. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Copper-Laminated Flashing: 7-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Advanced Building Products Inc.; Copper Fabric Flashing.
2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
3) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.

2. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch thick.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Carlisle Coatings & Waterproofing; Pre-Kleened EPDM Thru-Wall Flashing.
2) Firestone Specialty Products; FlashGuard.
3) Sandell Manufacturing Co., Inc.; EPDM Flashing.

C. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge or flexible flashing with a metal drip edge.

4. Where flashing is fully concealed, use metal flashing or flexible flashing.

D. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
3. Elastomeric Sealant: ASTM C 920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

C. Weep/Vent Products: Use one of the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity. Use only for weeps.
2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch OD by 4 inches long.
3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches long.
4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Advanced Building Products Inc.; Mortar Maze weep vent.
        2) Blok-Lok Limited; Cell-Vent.
        3) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
        4) Heckmann Building Products Inc.; No. 85 Cell Vent.
        5) Hohmann & Barnard, Inc.; Quadro-Vent.
        6) Wire-Bond; Cell Vent.

5. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

a. 1375: Subject to compliance with requirements, provide the following, or approved equal:

1) Mortar Net USA, Ltd.; Mortar Net Weep Vents.

D. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Products: Subject to compliance with requirements, provide one of the following, or approved equal:

a. Advanced Building Products Inc.; Mortar Break II.
b. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
c. Mortar Net USA, Ltd.; Mortar Net.

2. Provide one of the following configurations:

a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.

2.9 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

2.10 MORTAR MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar.
2. Use portland cement-lime mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide Type N unless another type is indicated.

D. Pigmented Mortar: Use colored cement product.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.
3. Application: Use pigmented mortar for exposed mortar joints with the following units:
   a. Face brick.
   b. Cast stone trim units.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored aggregate mortar for exposed mortar joints with the following units:
   a. Face brick.
   b. Cast stone trim units.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

C. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

D. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch; do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
2. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
3. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

A. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.7 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through sheathing to wall framing with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
3. Embed tie sections in masonry joints. Provide air space between back of masonry veneer and face of sheathing as shown on the drawings.
4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.

5. Space anchors as indicated, but not more than 18 inches o.c. vertically and 24 inches o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.

3.8 EXPANSION JOINTS

A. General: Install expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span expansion joints without provision to allow for in-plane wall or partition movement.

B. Form expansion joints in brick as follows:
   1. Build in compressible joint fillers where indicated.
   2. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.

   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.9 LINTELS

A. Install steel lintels where indicated.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

   1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
   2. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.

3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
5. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes 24 inches o.c. unless otherwise indicated.
4. Space weep holes formed from plastic tubing or wicking material 16 inches o.c.
5. Trim wicking material flush with outside face of wall after mortar has set.

E. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches, to maintain drainage.

F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

G. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products or open head joints to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

B. Inspections: Level 1 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

C. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

3.12 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
7. Clean stone trim to comply with stone supplier's written instructions.
8. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.13 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 042113

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Miscellaneous masonry accessories.
7. Masonry-cell insulation.

B. Related Sections:

1. Section 047200 "Cast Stone Masonry" for furnishing cast stone trim.
2. Section 055000 "Metal Fabrications" for loose steel lintels.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
2. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.6 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

1.7 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For testing agency.

C. Material Certificates: For each type and size of the following:

1. Masonry units.

    a. Include material test reports substantiating compliance with requirements.
    b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required in accordance with Form 816 Article 1.20-1.06.01.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate in accordance with Form 816 Article 1.20-1.06.01.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical wall area as shown on Drawings.
2. Build mockups for typical exterior wall in sizes approximately 48 inches long by 36 inches high by full thickness, including face and backup wythes and accessories.

    a. Include a sealant-filled joint at least 16 inches long in mockup.

3. Protect accepted mockups from the elements with weather-resistant membrane.
4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

    a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.

b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.

5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

F. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.10 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.3 CONCRETE MASONRY UNITS

A. CMUs: ASTM C 90.

1. Density Classification: Normal weight.
2. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

E. Aggregate for Grout: ASTM C 404.

F. Water: Potable.

2.5 REINFORCEMENT

A. Steel Reinforcing Bars: ASTM A 615/A 615M, Grade 60 epoxy coated according to ASTM A775/A775M.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: 0.148-inch diameter.
4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
6. Provide in lengths of not less than 10 feet with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
b. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
c. Wire-Bond; Figure 8 Rebar Positioner.

2.8 MASONRY-CELL INSULATION

A. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.

1. Products: Subject to compliance with requirements, provide the following:

a. Concrete Block Insulating Systems; Korfil.
b. Or approved equal.

2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
1. For reinforced masonry, use Type N.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 3000 psi.

3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

F. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

G. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY-CELL INSULATION

A. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.7 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.9 REINFORCED UNIT MASONRY INSTALLATION

A. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

B. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.10 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

B. Inspections: Level 1 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

D. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

E. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.11 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.12 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste.
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 047200 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Cast stone trim.
2. Window sills
3. Copings
4. Wall caps
5. Belt courses
6. Water tables

B. Related Sections:

1. Section 042113 " Brick Masonry" for installing cast stone units in brick masonry.
2. Section 034500 "Precast Architectural Concrete".

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

1. For cast stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1. Include building elevations showing layout of units and locations of joints and anchors.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For manufacturer.

C. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C 1364, including test for resistance to freezing and thawing.

1. Provide test reports based on testing within previous two years.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by the Architectural Precast Association or the Precast/Prestressed Concrete Institute for Group A, Category AT.

C. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

D. Source Limitations for Cast Stone: Obtain cast stone units through single source from single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.

C. Pack, handle, and ship cast stone units in suitable packs or pallets.

1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.
2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

1.7 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 CAST STONE MATERIALS

A. General: Comply with ASTM C 1364 and the following:

B. Portland Cement: ASTM C 150, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C 114. Provide natural color or white cement as required to produce cast stone color indicated.

C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C 33; gradation and colors as needed to produce required cast stone textures and colors.

D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C 33, gradation and colors as needed to produce required cast stone textures and colors.

E. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.

F. Admixtures: Use only admixtures specified or approved in writing by Architect.

1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
3. Air-Entraining Admixture: ASTM C 260. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
4. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
5. Water-Reducing, Retarding Admixture: ASTM C 494/C 494M, Type D.
6. Water-Reducing, Accelerating Admixture: ASTM C 494/C 494M, Type E.

G. Reinforcement: Deformed steel bars complying with ASTM A 615/A 615M, Grade 60. Use epoxy-coated reinforcement.

1. Epoxy Coating: ASTM A 775/A 775M.

H. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666, Type 304.

2.2 CAST STONE UNITS

A. Provide cast stone units complying with ASTM C 1364 using either the vibrant dry tamp or wet-cast method.

1. Provide units that are resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C 1364.

B. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
3. Provide drips on projecting elements unless otherwise indicated.

C. Fabrication Tolerances:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

D. Cure units as follows:

1. Cure units in enclosed moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
2. Keep units damp and continue curing to comply with one of the following:

a. No fewer than five days at mean daily temperature of 70 deg F or above.
b. No fewer than six days at mean daily temperature of 60 deg F or above.
c. No fewer than seven days at mean daily temperature of 50 deg F or above.
d. No fewer than eight days at mean daily temperature of 45 deg F or above.

E. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

F. Colors and Textures: As selected by Architect from manufacturer's full range.

2.3 MORTAR MATERIALS

A. Provide mortar materials that comply with Section 042113 "Brick Masonry."

2.4 ACCESSORIES

A. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666.

B. Dowels: 1/2-inch- diameter, round bars, fabricated from Type 304 stainless steel complying with ASTM A 240/A 240M, ASTM A 276, or ASTM A 666.

2.5 MORTAR MIXES

A. Comply with requirements in Section 042113 "Brick Masonry" for mortar mixes.

2.6 SOURCE QUALITY CONTROL

A. Engage a qualified independent testing agency to sample and test cast stone units according to ASTM C 1364.

1. Include one test for resistance to freezing and thawing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING CAST STONE IN MORTAR

A. Install cast stone units to comply with requirements in Section 042113 "Brick Masonry."

B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Coordinate installation of cast stone with installation of flashing specified in other Sections.

3.3 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.

B. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.

C. Fill anchor holes with sealant.

1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

D. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.

1. Form open joint of width indicated, but not less than 3/8 inch.

F. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

G. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.4 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

3.5 ADJUSTING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

END OF SECTION 047200

SECTION 0503100 – THERMAL SPRAY METALLIZING AND SEALER COATS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 PURPOSE:

A. This section provides the workmanship requirements for surface preparation, the shop application of a thermal spray (metallizing) coating and a seal coat of urethane. All work shall be done in the shop unless otherwise noted.

B. Unless otherwise directed by CTDOT, the coatings to be applied are as follows:

1. Application: Metalize and seal all exterior exposed bridge overpass structural steel systems – vertical window wall members and floor framing including deck.
2. The feedstock material used for metallizing must be one of the following: aluminum, zinc, 85/15 (Zn/Al) or 90/10 MMC.
3. The sealer coat to be applied over the metallizing is an acrylic urethane coating.

C. The General Contractor is responsible for coordinating the work to assure that the products of only one metallizing supplier and one sealer/paint manufacturer are utilized on the entire structure, including the necessary field touch-up work.

D. The Contractor(s) are required to implement and maintain programs and procedures which comply with the requirements of the specifications and all applicable Federal, state, and local OSHA and EPA standards and regulations. The Contractor is cautioned that it must comply with all applicable regulations even if the regulation is not specifically referenced herein. If a state or local regulation is more restrictive than the requirements of this specification, the more restrictive requirements prevail.

1.3 PRE-METALLIZING MEETING

A. A mandatory pre-metallizing meeting will be held prior to the beginning of any metallizing work. This meeting will be held separately from other general construction meetings for the overall project.

B. The following parties are required to attend this meeting: General Contractor, Metallizing Contractor, Coating Contractor, Thermal Spray Feedstock and Paint Manufacturer, Metallizing Equipment Manufacturer, Project Engineer, Paint Inspector, Test Laboratory, CTDOT Personnel and other parties as deemed appropriate by the Engineer.

1.4 REFERENCE STANDARDS

A. The latest edition of the following standards and regulations form a part of this specification.

1. American Society for Testing and Materials (ASTM)

   a. ASTM D1400, Standard Test Method for Non-Destructive Measurement of Dry Film Thickness of Non-Conductive Coatings Applied to a Non-ferrous Metal Base
   b. ASTM D3359, Standard Test Methods for Measuring Adhesion by Tape Test
   c. ASTM D4138, Standard Test Method for Measurement of Dry Paint Thickness of Protective Coating Systems by Destructive Means
   d. ASTM D4285, Standard Test Method for Indicating Oil or Water in Compressed Air
   e. ASTM D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages
   f. ASTM D4417, Standard Test Methods for field Measurement of Surface Profile of Blast Cleaned Steel
   g. ASTM D 4940, Standard Test Method for Conductmetric Analysis of Water-Soluble Ionic Contamination of Blasting Abrasive

2. American Welding Society

   a. ANSI/AWS C2.18-93 Guide for the Protection of Steel with Thermal Sprayed Coatings of Aluminum and Zinc and Their Alloys and Composites.
   b. ANSI/AWS A5.33, “Specification for Solid and Ceramic Wires and Ceramic Rods for Thermal Spraying.”

3. Code of Federal Regulations (CFR)

   a. 29 CFR 1926, Occupational Safety and Health Regulations for the Construction Industry
   b. 29 CFR 1926.104, Safety Belts, Lifelines, and Lanyards
   c. 29 CFR 1926.105, Safety Nets
   d. 29 CFR 1926.451, Scaffolding
   e. Society for Protective Coatings (SSPC)
   f. SSPC-SP 1, Solvent Cleaning
   g. SSPC-SP 2, Hand Tool Cleaning
   h. SSPC-SP 3, Power Tool Cleaning
   i. SSPC-SP 10, Near White Metal Blast Cleaning
   j. SSPC-PA 2, Measurement of Dry Film Thickness with Magnetic Gages
   k. SSPC-VIS 1, Visual Standard for Abrasive Blast Cleaned Steel
   l. SSPC-VIS 3, Visual Standard for Hand and Power Tool Cleaned Steel
   m. SSPC-AB1, Abrasive Specification No. 1
   n. SSPC-AB2, Specification for Cleanliness of Recycled Ferrous Metal Abrasives

o. SSPC-AB4, Newly Manufactured or Re-Manufactured Steel Abrasives
p. SSPC-QP1, Standard Procedure for Evaluating Qualifications of Painting Contractors: Shop Applicators
q. SSPC-CS 23.00, Guide for Thermal Spray Metallic Coating Systems

4. Equipment and Metallizing Material and Coating Manufacturers' Published Instructions

1.5 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR-SUBMITALS.

B. Submit the following plans and programs to CTDOT for review and acceptance a minimum of fifteen (15) days prior to metallizing.

C. Surface Preparation/Metallizing and Sealing/Painting Plan

1. Provide written procedures for the preparation of surfaces and the application of the metallizing and the urethane sealer. Also include a procedure for the repair and touch up of any damage that occurs to the newly applied metallizing or coatings.
2. Provide a written QA/QC plan. Include quality control checkpoints for surface preparation, metalize application, adhesion testing of metallizing application and coating thickness measurements.
3. Identify the metallizing and coating materials to be applied. Include manufacturer's name, product names, and product numbers. Provide Product Data Sheets, VOC levels for liquid coatings, MSD sheets, and written application instructions including mixing requirements, specified thinners, and thinner amounts for liquid coatings.
4. Identify the type and brand name of the abrasive proposed for use.
5. In the event of a conflict between the manufacturer's technical data and this section, this section will govern unless the manufacturer's requirements are more restrictive.
6. Identify the thermal spray equipment to be used to apply the feedstock.

D. Work Schedule - Provide a schedule for surface preparation, metallizing and sealing/painting. CTDOT shall be notified a minimum of one week prior to starting work.

E. CTDOT Review

1. Do not construe CTDOT acceptance of Contractor submittals to imply approval of any particular method or sequence for conducting the work, or for addressing health and safety. Acceptance of the programs does not relieve the Contractor from the responsibility to conduct the work in strict accordance with the requirements of this section, or to adequately protect the health and safety of all workers involved in the project including any members of the public who may be affected by the project.
2. The Contractor remains solely responsible for the adequacy and completeness of the programs and work practices and adherence to them.

1.6 SUPERINTENDENCE BY THE METALLIZING AND PAINTING CONTRACTORS

A. The Metallizing and Painting Contractors are responsible for supervising and directing the coat-

ing work efficiently using the best skills and attention, and are solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. Keep an experienced, competent, resident superintendent acceptable to CTDOT on the project at all times. Do not replace the superintendent except under extraordinary circumstances, and only upon approval of the CTDOT.

C. The superintendent is the Metallizing and Painting Contractors' representative and must have the authority to act on behalf of the Contractor. All communications given to the superintendents are binding upon the Contractor.

1.7 CONTRACTOR/WORKER QUALIFICATIONS

A. The Metallizing Contractor shall be certified by the SSPC Painting Contractor Certification Program QP-3, entitled "*Standard Procedure for Evaluating Qualifications of Shop Painting Contractors*" in the *enclosed shop* category or be certified in the American Institute of Steel Construction (AISC) Sophisticated Paint Endorsement (SPE) category – *enclosed shop* P1 or *covered shop* P2. A list of approved contractors can be found on the AISC website at www.AISC.org. The Metallizing Contractor shall be fully certified, including endorsements, for the duration of the time they are doing surface preparation and coating application.

B. The complete coating system shall be applied in an enclosed shop except for field touch-up painting which shall be applied after all bolts are fully tensioned and deck form work removed. The enclosed shop shall be a permanent facility with outside walls to grade and a roof where surface preparation and coating activities are normally conducted in an environment not subject to outdoor weather conditions and/or blowing dust.

C. All metallizing and coating work shall be performed by a Contractor with at least two years of experience performing metallizing of structural steel. Prior to the pre-metallizing meeting as per 1.02 A., the Contractor shall submit written documentation of at least three successful metallizing projects in the last three years. Information shall include the name of owner of each metallizing project, number and location of each job and year each job was completed. The Contractor shall possess knowledge and experience in all areas of the surface preparation and metallizing work. This documentation will be reviewed and verified by CTDOT prior to beginning work on this project.

D. Each spray operator shall be qualified to metalize according to ANSI/AWS C2.18-93. Any operator who does not show evidence of qualification shall not be allowed to spray.

E. Technical Advisors: It is mandatory that the Contractor obtains the services of qualified technical advisors that represent the coating manufacturer, the thermal spray feedstock manufacturer, and the metallizing application equipment manufacturer. The Contractor shall make all necessary arrangements for technical advisor site visits. The technical advisors shall assist the Engineer and the Contractor in establishing the correct application methods for the metallizing and painting.

1.8 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Warranty Period: Manufacturer's standard, but not less than 5-years from the issuance of the Certificate of Compliance.

PART 2 - PRODUCTS

2.1 ABRASIVES

A. Provide abrasives that are clean, dry, and sized properly to provide the surface profile required by this section.

B. Use abrasives that are acceptable to CTDOT. Abrasives shall be hard and sharp in order to produce an angular surface profile. Acceptable abrasives include, but are not limited to, angular aluminum oxide, angular steel grit and angular crushed slag. Silica sand shall not be used. Steel shot and other abrasives that produce a rounded surface profile shall not be used.

C. Abrasives shall conform to the following:

1. SSPC AB 1 for mineral slag abrasives
2. SSPC AB 2 for recycled ferrous metal abrasives
3. SSPC AB 3 for new steel abrasives

2.2 COATING MATERIALS

A. Thermal Spray Feedstock - Provide the type and quantity of thermal spray feedstock needed to metalize all carbon steel surfaces in the field and then seal those surfaces.

1. The zinc, aluminum, alloy or metal matrix composite (MMC) shall be manufactured for thermal arc spraying and shall have a chemical composition that meets the requirements that meets ANSI/AWS A5.33, “Specification for Solid and Ceramic Wires and Ceramic Rods for Thermal Spraying.”
2. The Contractor shall provide a certificate of the chemical composition of the feedstock from the feedstock supplier.

B. Urethane Sealer – Provide the type and quantity of urethane sealer needed to seal all surfaces of the metallizing.

1. The seal coat shall be a urethane applied over all metallizing in accordance with the manufacturer’s requirements. The products of Carboline Company and Sherwin Williams Company listed below are examples of the standard of quality to be achieved. Equivalent products of other manufacturers may be submitted to CTDOT for consideration:

   a. Carboline: *Carbothane 133 Series, LH*
   b. Sherwin Williams: *High Solid Polyurethane B65*
   c. Devoe: *Devthane 379UVA*
   d. Designer Approved Equal subject to compliance with specifications.

2. Use a single manufacturer to supply all thermal spray feedstock, and a single manufactur-

er to supply the coating materials and including thinners, additives, and touch-up coatings. Do not co-mix coating products or components produced by different manufacturers under any circumstances.

3. Only use materials that are packaged and sealed, original, labeled containers bearing manufacturer's name, type of material, brand name, shelf life, batch number, and instruction for mixing and thinning.

4. Colors: As specified in the Contract Drawings.

2.3 CAULKING MATERIALS - When caulking is required, provide 100% solids material that is recommended by the coating manufacturer.

2.4 SURFACE PREPARATION, THERMAL SPRAYING, AND PAINTING EQUIPMENT

A. Provide thermal spray metallizing, and surface preparation and painting equipment in accordance with the requirements of this section.

B. Use equipment and materials that are clean and sized properly to accomplish the work, including the required surface profile and finish as required by this section.

C. The thermal spray equipment shall be gas or electric arc equipment set up, calibrated, and operated in accordance with the manufacturer's written instructions. Proper set up and functioning of equipment shall be verified by performing tests in accordance with Part 3.02 F.3. of this section.

2.5 PERSONAL PROTECTIVE EQUIPMENT

A. Provide all of the necessary personal protective equipment (PPE) for the project to assure that workers are protected from hazards during surface preparation, metallizing, coating application, and clean-up activities.

B. Furnish and have available to the Engineer, two new NIOSH/MESA approved thermal spray air respirators and other safety equipment needed to permit the inspection of ongoing metallizing/coating work.

C. Repair or replace PPE as required to assure that it continues to provide its' intended purpose.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Weld Spatter, Sharp Edges, and Holes

1. Remove slag, flux deposits, and weld spatter and steel irregularities such as fins, tears and slivers. Grind any resulting burrs smooth, including burrs around holes.

2. All corners and edges shall be rounded to a 1/16-inch radius or chamfered to a 1/16-inch chamfer.
3. Flame cut edges shall be ground over their entire surface such that any hardened surface layer is removed, and subsequent abrasive blast cleaning produces the specified surface profile depth.

B. Pre-Surface Preparation Cleaning of Steel

1. Prior to surface preparation, remove visible grease and oil, etc. from bridge surfaces in accordance with SSPC-SP 1 using only solvents or detergents acceptable to the coating manufacturer and CTDOT. The use of pressurized water for this cleaning is also acceptable.
2. Use clean cloths for the final wiping.

C. Compressed Air Cleanliness

1. Provide compressed air that is free from moisture and oil contamination.
2. Verify the cleanliness of the compressed air by the white blotter test in accordance with ASTM D4285 at least once per shift for each compressor system. Sufficient freedom from oil and moisture is confirmed if soiling or discoloration are not visible on the paper.
3. If air contamination is evident, change filters, clean traps, add moisture separators or filters, or make adjustments as necessary to achieve clean, dry air.

D. Ambient Conditions: Do not conduct final surface preparation which exposes bare steel under damp environmental conditions or when the surface temperature is less than 5° F greater than the dew point temperature of the surrounding air.

E. Abrasives/Profile

1. Use clean, dry, uniformly graded recyclable steel or disposable abrasives for blast cleaning that are free of oil, soluble salts and other similar substances that could contaminate the blast cleaned surface.
2. Provide abrasive that is sized to produce a sharp, angular, uniform surface profile to a minimum height of 3.0 mils, unless the requirements of the metallizing products are otherwise. Measure the profile using the Keane-Tator Surface Profile Comparator or Testex Replica Tape in accordance with ASTM D4417.

F. Pre-Production Test Sections

1. Prior to proceeding with production surface preparation operations, blast clean and metalize at least 9 square feet of steel surface.
2. Use the same metallizing equipment, set up, materials, and calibration and operating procedures in the test section(s) that will be used for the production operations.
3. Spray parameters should be set for spraying the submitted feedstock and at a minimum, be validated by passing a bend test as follows:

    a. Spray five carbon steel coupons with approximate dimensions of 2 x 4 to 8 x 0.050 inches. The surface of the coupons should be prepared to the same degree as specified for the project. Bolt, bracket or otherwise fasten the coupons to larger pieces of stock during the blast cleaning and metallizing operations.
    b. Spray metallizing 8 to 10 mils thick in a right angle cross hatch spray passes laying

down approximately 3 to 4 mils per pass.

4. Metalographic analysis of additional coupons may be required by CTDOT to establish the suitability of the surface preparation and the thermal spray coating. Supply, prepare, and thermal spray coat these panels using the same materials, equipment and process parameters for the contract work at no additional cost to CTDOT.
5. Provide safe access for close visual inspection and testing.
6. Do not proceed with production surface preparation activities until CTDOT agrees that the surfaces of the test section has been prepared to conform with the requirements.

3.2 SEALER/PAINT AND METALLIZING MATERIAL STORAGE, MIXING, AND HANDLING

A. Sealer/Paint and Metallizing Material Storage

1. Keep all containers unopened until required for use.
2. Store all sealer/paint, metallizing materials (i.e. feedstock wire), thinners, and solvents in accordance with OSHA regulations and the requirements of the manufacturer. Store the materials under cover, out of direct sunlight. Maintain the temperature between 40ºF and 90ºF, unless the requirements of the manufacturer are more restrictive.
3. Provide the size and number of fire extinguishers in proper proportion to the quantity of sealer/paint stored.
4. Do not permit smoking in sealer/paint storage, mixing, and application areas.
5. Do not open or mix sealer/paint in the storage area.
6. Do not return mixed sealer/paint to the storage area.
7. Bulk containers for solvents and thinners must be equipped with spring-loaded, self- closing, dispensing nozzles. Use Underwriter's Laboratories approved containers for transporting paint to mixing areas.
8. Use explosion-proof lighting fixtures.
9. Do not permit the accumulation of empty sealer/paint cans, combustibles, and other debris.
10. Maintain MSDS for all materials.

B. Mixing and Thinning of Sealer/Paint Materials

1. Verify that the sealer/paint to be mixed has not exceeded its' shelf life. When required by the manufacturer, warm paints stored at less than 40^{o}F to above 50^{o}F prior to mixing.
2. Utilize proper ventilation in the mixing area to prevent injury to workmen or the accumulation of volatile gases.
3. Mix all sealer/paint coatings in accordance with the requirements of the coating manufacturer.
4. Mix only complete kits of material. Mixing of partial kits is not allowed.
5. Do not use two component materials beyond the pot life established by the manufacturer's written instructions.
6. Thin sealer/paint in strict accordance with the coating manufacturer’s written instructions. Use only those types, brands, and amounts of thinner recommended by the coating manufacturer. Limit the thinning to the minimum amount necessary to facilitate application except for the mist coat of urethane sealer applied over metallizing. Unless directed otherwise by the coating manufacturer, thin the sealer coating approximately 25% and first apply as a mist coat to seal the surface. When the mist coat has penetrated the metal-

lizing, follow with the full coat with proper thinning.

3.3 COATING APPLICATION

A. Quality of Surface Preparation

1. Verify that the surface exhibits the specified SSPC-SP10 degree of cleaning immediately prior to metallizing.

B. Surface Cleanliness - Thoroughly clean the surface of each coat prior to the application of the next to remove overspray, spent abrasive, dirt, dust, and other interference material.

C. Grease/Oil - If grease or oil have become deposited on the bare steel or on the surface of any of the applied coats, remove by solvent cleaning in accordance with SSPC-SP1 prior to the application of the next coat.

D. Ambient Conditions -Apply metallizing and sealer/paint under the following conditions unless the requirements of the coating manufacturer are more restrictive.

1. Relative Humidity - Less than 85%.
2. Frost/Rain - Do not apply coatings to surfaces containing frost or during rain, fog, or similar conditions.
3. Remove and replace any coating that is damaged or marred from exposure to unacceptable conditions (e.g. rain or dew) prior to adequate curing.

E. Metallizing Application

1. The coating shall be applied in a neat and workmanlike manner and shall be applied uniformly and shall be free of ridges or other defects. The coating shall be applied by thermal spray employing multiple passes to achieve a thickness of 0.008 to 0.010 inches (8-10 mils). No single pass shall deposit more than 0.004 inches.
2. A cut test shall be performed at the end of each shift to confirm that metallizing is being properly applied. The cut test consists of a single cut 1.5 inches long through the thermal spray coating to the substrate without severely cutting the substrate. A cut shall be made with a hammer and sharp chisel. The chisel cut should be made at a shallow angle. The bond of the metallizing is considered unsatisfactory if any part of the metallizing lifts from the substrate along the cut.
3. Spraying shall be performed in a block pattern, typically 2 square feet or as per the equipment manufacturer’s written recommendation. Overlapping spray passes to ensure uniform coverage, and produce the required thickness and uniformity. A minimum of two passes are required, overlapping and at right angles to each other. The gun shall be held at such a distance from the work surfaces so that the metal is still plastic on impact, typically 5 to 8 inches from the surface. The coating shall be firmly adherent and free from uncoated spots, lumps or blisters, and have a fine sprayed texture.
4. Special care shall be exercised to avoid contamination of surrounding areas or property by over spraying. Containment tarps should be used when spray application is performed.
5. The work area shall be properly ventilated to assure proper worker protection.

F. Metallizing Adhesion: Adhesion strength of the metallizing shall be 700 psi minimum as meas-

ured with approved equipment as per ASTM D4541 using apparatus under Annex A4. All adhesion test locations shall be re-metalized in accordance with this specification at no additional cost. Measurements shall be taken every 500 square feet. If adhesion is less than 700 psi but greater than 560 psi, four additional adhesion tests shall be made. If any of the additional adhesion tests are less than 700 psi, the coating shall be removed and re-applied at the Contractor's expense. Any adhesion test result less than 560 psi, will be grounds for the Contractor to remove the entire coating at their expense.

G. Sealer/Paint Application

1. Apply all sealer/paint by the methods shown below unless the methods recommended by the sealer/paint manufacturer are more restrictive. Apply the sealer/paint to all previously metalized surfaces. In no cases shall the seal coat be applied over visible oxidation of the metallizing.
2. Apply the sealer/paint in a two-coat operation, a mist coat and a full coat. Thin the mist coat up to the manufacturer's written maximum amount using the recommended thinner in order to penetrate the metallizing layer. Apply the full finish sealer/paint coat without thinning.
3. Airless or conventional spray application - If conventional spray is used, verify that the compressed air supply is clean and dry as determined by the blotter test. When spraying, use extreme care to avoid contamination of surrounding areas or property by overspray.
4. Brush or roller application - Brushes or rollers may be used to control overspray, or for localized application such as touch-up, in areas of limited accessibility for spraying, or for stripe coating.

H. Recoat Times For Liquid Coatings

1. Apply each coat only after the previous coat has been allowed to dry as required by the manufacturer's written instructions, but as soon as possible to minimize the length of time that the coating is exposed to dust and contamination.
2. Do not allow any coat to remain exposed for longer than fourteen (14) calendar days prior to overcoating.

I. Coverage and Continuity

1. Apply each coat to assure thorough wetting of the substrate or underlying coat, and to achieve a smooth, streamline surface relatively free of dryspray, overspray, and orange peel. Shadow-through, pinholes, bubbles, skips, misses, lap marks between applications, or other visible discontinuities in any coat are unacceptable. Runs or sags in liquid coatings may be brushed out while the material remains wet. If the discontinuities remain in the film after drying, remove and replace the defective coating as described later in the "Repair" section of this specification.
2. Thoroughly coat all surfaces with special attention to hard-to-reach areas, and irregular surfaces. Some configurations may require spraying from multiple directions to assure complete coverage.

J. Tint - Tint successive coats (if approved by the manufacturer), or use materials of sufficiently different color to facilitate proper coverage and to provide a visual distinction between coats.

K. Sealer/Paint Adhesion

1. Apply sealer/paint in such a manner to assure that they are well-adherent to each other and to the underlying surface. If the application of any coat causes lifting of an underlying coat, or there is poor adhesion between coats or to the substrate, remove the coating in the affected area to adjacent sound, adherent, coating, and reapply the material.
2. If sealer/paint adhesion is suspect, conduct adhesion tests in accordance with ASTM D3359 or ASTM D4541 as directed by CTDOT and repair all test areas. The acceptance criteria for the testing will be established by CTDOT and the coating manufacturer. Replace all defective coating that is revealed by the testing.

L. Wet Film Thickness - Use wet film thickness gages in accordance with ASTM D4414 to verify the thickness of each liquid coat at the time of application.

M. Dry Film Thickness

1. Apply each coat to the thicknesses specified below:

Metallizing	8 to 10 mils
Urethane Sealer	2 to 4 mils
TOTAL SYSTEM	10 to 14 mils

2. Measure the thickness of each coat using nondestructive magnetic dry film thickness gages. Comply with SSPC-PA2 for the calibration and use of the gages, and the frequency of thickness measurements. Spot readings both 20% above and 20% below the thicknesses shown above are permitted, provided the average thicknesses are within the specified tolerances.
3. If there are questions regarding the non-destructive measurements of coating thickness, a Tooke Gage (destructive scratch gage) may be used when authorized by CTDOT. Conduct measurements in accordance with ASTM D4138, but limit its' use to a minimum of locations. Mark and repair all damage caused by the destructive testing, whether created by CTDOT or the Contractor.
4. Apply additional coating to areas of insufficient thickness with care to assure that all repairs blend in with the surrounding material.
5. Unless directed otherwise by CTDOT, remove excessive coating thickness and reapply the affected coat(s).

3.4 REPAIR OF FILM DISCONTINUITIES AND DAMAGE TO COATING SYSTEM AFTER ERECTION

A. Surface Preparation of Film Discontinuities or Damage

1. Remove localized film discontinuities (e.g., runs, sags, shadow-through, etc.) or damage and corrosion by solvent cleaning in accordance with SSPC-SP 1 followed by sanding or power tool cleaning.
2. In damaged metalized areas, if the repair operation exposes the substrate, remove all loose material and prepare the steel in accordance with SSPC-SP 5 and achieve a uniform and dense surface profile of 2 to 4 mils.
3. If the substrate is not exposed, remove all loose material and prepare the surface in accordance with SSPC-SP 3.

B. Feathering of Repair Areas

1. Feather the existing material surrounding each repair location. Feather for a distance of 1 to 2 inches to provide a smooth, tapered transition into the existing intact coating.
2. Verify that the edges of coating around the periphery of the prepared areas is tight and intact by probing with a putty knife in accordance with the requirements of SSPC-SP3. Roughen the existing coating in the feathered area to assure proper adhesion of the repair coats.

C. Coating Application

1. When the bare substrate is exposed in the repaired area, apply the metallizing and urethane sealer/paint.
2. When the repair does not extend to the bare substrate, apply only the seal coats.
3. Maintain the thickness of the system in overlap areas within the specified total thickness tolerances.

3.5 INSPECTION

A. CTDOT may inspect any or all phases of the Work to verify that it is in accordance with the requirements of this section. Facilitate this inspection as required, including allowing ample time for the inspections and access to the work. Inspections may include, but are not limited to, surface preparation, pre-painting cleanliness, paint application, dry film thickness, film appearance and continuity, and adhesion.

B. The presence or activity of CTDOT inspections in no way relieves the Contractor of the responsibility to comply with all requirements of this Section and to provide adequate inspections of its' own.

C. Furnish, until final acceptance of the coating system, all equipment and instrumentation needed to inspect all phases of the work.

3.6 ONE-YEAR ANNIVERSARY INSPECTION

A. A one-year anniversary inspection will be conducted approximately twelve months after the structure has been erected. Provide for all aspects of this inspection (i.e. access, rigging, safety traffic control, etc.) and participate in this inspection with CTDOT. All at no additional cost to CTDOT.

B. Repair, at no cost to CTDOT, all locations where the coating exhibits disbonding, cracking, rusting, or other such defects. Perform all repairs in accordance with this Section and the coating manufacturer's written instructions.

END OF SECTION 050310

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Field-installed shear connectors.
3. Grout.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other steel items not defined as structural steel.
4. Section 099600 "High-Performance Coatings" for surface-preparation and priming requirements.

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches.

2. Welded built-up members with plates thicker than 2 inches.
3. Column base plates thicker than 2 inches

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.4 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the Seismic-Load-Resisting System.
6. Indicate locations and dimensions of protected zones.
7. Identify demand critical welds.

D. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint [whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand critical welds.

E. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer, fabricator, professional engineer and testing agency.

C. Welding certificates.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Nonshrink grout.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

D. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

C. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator**,** including comprehensive engineering analysis by a qualified professional engineer**,** to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC 360.
2. Use Allowable Stress Design; data are given at service-load level.

B. Moment Connections: Type PR, partially restrained.

C. Construction: Moment frame.

2.3 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M, Grade 50.

B. Channels and Angles: ASTM A 36/A 36M.

C. Plate and Bar: ASTM A 36/A 36M.

D. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53/A 53M, Type E, Grade B.

1. Weight Class: Standard
2. Finish: Black.

F. Welding Electrodes: Comply with AWS requirements.

2.4 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain.

C. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

D. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436, Type 1, hardened carbon steel.
4. Finish: Plain.

2.5 PRIMER

A. Primer: Comply with Section 099600 "High-Performance Coatings."

2.6 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.7 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.8 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened unless noted as slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.9 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates and leveling plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten or pretension anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened unless noted as slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

B. Touchup Painting: Cleaning and touchup painting are specified in Section 099600-"High Performance Coatings."

END OF SECTION 051200

SECTION 051213 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes architecturally exposed structural-steel (AESS).

1. Requirements in Section 051200 "Structural Steel Framing" also apply to AESS.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for additional requirements applicable to AESS.
2. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other metal items not defined as structural steel.
3. Section 099600 "High-Performance Coatings" for surface preparation and priming requirements.

1.3 DEFINITIONS

A. AESS: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Shop Drawings: Show fabrication of AESS components. Shop Drawings for structural steel may be used for AESS provided items of AESS are specifically identified and requirements below are met for AESS.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Indicate grinding, finish, and profile of welds.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections. Indicate orientation of bolt heads.
5. Indicate exposed surfaces and edges and surface preparation being used.
6. Indicate special tolerances and erection requirements.

C. Samples: Submit Samples of AESS to set quality standards for exposed welds.

1. Two steel plates, 3/8 by 8 by 4 inches, with long edges joined by a groove weld.

1.6 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer and fabricator.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Use special care in handling to prevent twisting, warping, nicking, and other damage. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 FIELD CONDITIONS

A. Field Measurements: Where AESS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, round-head assemblies, consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain.

2.3 FILLER

A. Filler: Polyester filler intended for use in repairing dents in automobile bodies.

2.4 PRIMER

A. Primer: Comply with Section 099600 "High-Performance Coatings."

2.5 FABRICATION

A. Shop fabricate and assemble AESS to the maximum extent possible. Locate field joints at concealed locations if possible. Detail assemblies to minimize handling and to expedite erection.

B. In addition to special care used to handle and fabricate AESS, comply with the following:

1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
2. Grind sheared, punched, and flame-cut edges of AESS to remove burrs and provide smooth surfaces and edges.
3. Fabricate AESS with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
4. Fabricate AESS with exposed surfaces free of seams to maximum extent possible.
5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
7. Fabricate AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
8. Seal-weld open ends of hollow structural sections with 3/8-inch closure plates for AESS.

C. Curved Members: Fabricate indicated members to curved shape by rolling to final shape in fabrication shop.

1. Distortion of webs, stems, outstanding flanges, and legs of angles shall not be visible from a distance of 20 feet under any lighting conditions.
2. Tolerances for walls of hollow steel sections after rolling shall be approximately 1/2 inch.

D. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch with a tolerance of 1/32 inch for AESS.

E. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened unless noted as slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work, and comply with the following:

1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding specified tolerances.
2. Use weld sizes, fabrication sequence, and equipment for AESS that limit distortions to allowable tolerances.
3. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.
4. Provide continuous welds of uniform size and profile where AESS is welded.
5. Grind butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus zero inch for AESS.
6. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for AESS.
7. At locations where welding on the far side of an exposed connection of AESS occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
8. Make fillet welds for AESS oversize and grind to uniform profile with smooth face and transition.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Examine AESS for twists, kinks, warping, gouges, and other imperfections before erecting.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep AESS secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work.

3.3 ERECTION

A. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

1. Erect AESS to the tolerances specified in AISC 303 for steel that is designated AESS.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened unless noted as slip critical.
2. Orient bolt heads in same direction for each connection and to maximum extent possible in same direction for similar connections.

B. Weld Connections: Comply with requirements in "Weld Connections" Paragraph in "Shop Connections" Article.

1. Remove backing bars or runoff tabs; back-gouge and grind steel smooth for AESS.
2. Remove erection bolts in AESS, fill holes, and grind smooth.
3. Fill weld access holes in AESS and grind smooth.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect AESS as specified in Section 051200 "Structural Steel Framing." The testing agency is not responsible for enforcing requirements relating to aesthetic effect.

B. Architect will observe AESS in place to determine acceptability relating to aesthetic effect.

3.6 REPAIRS AND PROTECTION

A. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Grind steel smooth.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099600-"High Performance Coatings."

END OF SECTION 051213

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Roof deck.
2. Composite floor deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of deck, accessory, and product indicated.

C. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Welding certificates.

C. Product Certificates: For each type of steel deck.

D. Evaluation Reports: For steel deck.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

B. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

C. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.3 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Canam United States; Canam Group Inc.
2. Consolidated Systems, Inc.; Metal Dek Group.
3. Nucor Corp.; Vulcraft Group.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G90 zinc coating.
2. Deck Profile: Type WR, wide rib.
3. Profile Depth: 1-1/2 inches.
4. Design Uncoated-Steel Thickness: 0.0474 inch.
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.4 COMPOSITE FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Canam United States; Canam Group Inc.
2. Consolidated Systems, Inc.; Metal Dek Group.
3. Nucor Corp.; Vulcraft Group.

B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 50, G60 zinc coating.
2. Profile Depth: 3 inches.
3. Design Uncoated-Steel Thickness: 0.0474 inch.
4. Span Condition: As indicated.

2.5 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

C. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

D. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated.

E. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

F. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

G. Galvanizing Repair Paint: ASTM A 780.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: 5/8 inch, nominal.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 12 inches apart in the field of roof and 6 inches apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 36 inches, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: 5/8 inch, nominal.
2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:
1. Fasten with a minimum of 1-1/2-inch-long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped or butted at Contractor's option.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

F. Install piercing hanger tabs at 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.6 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Roof rafter framing.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of cold-formed steel framing product and accessory.

C. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

D. Delegated-Design Submittal: For cold-formed steel framing.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For testing agency and professional engineer.

C. Welding certificates.

D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

B. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Craco Mfg., Inc.
2. ClarkDietrich Building Systems.
3. MarinoWARE.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer licensed in the State of Connecticut to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height.
   b. Roof Rafter Framing: Vertical deflection of 1/240 of the horizontally projected span for live loads.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Design Standards:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

2.4 COLD-FORMED STEEL FRAMING, GENERAL

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: Minimum of G90 or equivalent for masonry veneer stud backup applications. Minimum of G60**,** A60**,** AZ50, or GF30 for all other applications.

B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: As required by structural performance.
2. Coating: G60.

2.5 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Flange Width: 1-5/8 inches, minimum.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.
2. Flange Width: 1-1/4 inches.

C. Vertical Deflection Clips: Manufacturer's standard bypass or [head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Craco Mfg., Inc.
b. ClarkDietrich Building Systems
c. MarinoWARE.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Flange Width: 1 inch plus twice the design gap.

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

    a. Minimum Base-Metal Thickness: 0.0538 inch.
    b. Flange Width: 1 inch plus twice the design gap.

2. Inner Track: Of web depth indicated, and as follows:

    a. Minimum Base-Metal Thickness: 0.0538 inch.
    b. Flange Width: Dimension equal to sum of outer deflection track flange width plus 1 inch.

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

2.6 ROOF-RAFTER FRAMING

A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Flange Width: 1-5/8 inches, minimum.

2.7 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

2.8 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.9 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.

C. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.10 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to bypassing studs and anchor to building structure.
4. Connect drift clips to cold-formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

   a. Install solid blocking at 96-inch.
2. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:
1. Pit Ladder.
2. Steel framing and supports for electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Miscellaneous steel trim.
5. Loose bearing and leveling plates.

B. Products furnished, but not installed, under this Section include the following:

1.3 Loose steel lintels.PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For qualified professional engineer.

C. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication. When shop drawings are submitted based on field measurements those field measurements shall also be submitted for the Engineer’s use.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.9 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 316L.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 316L.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

F. Steel Tubing: ASTM A 500, cold-formed steel tubing.

G. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless-steel fasteners for fastening aluminum.
   2. Provide stainless-steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 2.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

   1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Eyebolts: ASTM A 489.

G. Machine Screws: ASME B18.6.3.

H. Lag Screws: ASME B18.2.1.

I. Wood Screws: Flat head, ASME B18.6.1.

J. Plain Washers: Round, ASME B18.22.1.

K. Lock Washers: Helical, spring type, ASME B18.21.1.

L. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

M. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

N. Post-Installed Anchors: chemical anchors.
   1. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

E. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 PIT LADDER

A. Ladder Fabrication: Comply with ANSI A14.3 and OSHA approved. Unless otherwise indicated, provide 3/8" x 1-1/2" bar side rails spaced 18" apart with 3/4" diameter solid structural steel bar rungs at 12" on center vertically. Rungs shall have non-slip top surface as provide by the manufacturer. Provide extended side rails at least 42" above top rung and return to wall or structure. Fit rungs in holes drilled in side rails. Weld and grind smooth to touch. Securely anchor each ladder side rail with clip angles at top, bottom and intermediate points spaced not more than 5'-0" on center. Provide 7" clearance from walls to centerline of rungs. Final finish paint system to match that of canopy steel.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primer specified in Section 099600 "High-Performance Coatings" where indicated.

2.8 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim where indicated.

D. Prime miscellaneous steel trim with primer specified in Section 099600 "High-Performance Coatings."

2.9 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates where indicated.

C. Prime plates with primer specified in Section 099600 "High-Performance Coatings."

2.10 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with primer specified in Section 099600 "High-Performance Coatings."

2.11 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.12 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.13 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 099600 "High-Performance Coatings".

C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099600 "High-Performance Coatings".

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 055100 - METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Preassembled steel stairs with abrasive-coating-finished formed-metal treads.
2. Industrial-type stairs with steel grating treads.

B. Related Sections:
1. Section 055000 "Metal Fabrications" for metal treads and nosings installed at locations other than in metal stairs.
2. Section 055213 "Pipe and Tube Railings" for pipe and tube railings.
3. Section 099600 “High Performance Coatings” for steel prep and paint coatings on metal stairs.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft..
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor is 1.5.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For metal stairs and the following:
1. Metal floor plate treads.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For qualified professional engineer.

C. Welding certificates.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs.

1. Test railings according ASTM E 894 and ASTM E 935.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: Fabricator of products.

C. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
   1. Ornamental Stairs: Architectural class.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.

C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

D. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

E. Wire Rod for Grating Crossbars: ASTM A 510.

F. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

G. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30, unless another grade is required by design loads.

H. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 coating, structural steel, Grade 33, unless another grade is required by design loads.

2.3 ABRASIVE NOSINGS

A. Cast-Metal Units: Cast nickel silver, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. American Safety Tread Co., Inc.
   b. Balco Inc.
   c. Barry Pattern & Foundry Co., Inc.
   d. Granite State Casting Co.
   e. Safe-T-Metal Company, Inc.
   f. Wooster Products Inc.

2. Configuration: Cross-hatched units, 4 inches wide without lip.
3. Configuration: Cross-hatched angle-shaped units, same depth as bar-grating treads and 1 to 1-1/2 inches wide.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

D. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.4 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts or stainless steel for all stairs.

D. Machine Screws: ASME B18.6.3.

E. Lag Screws: ASME B18.2.1.

F. Plain Washers: Round, ASME B18.22.1.

G. Lock Washers: Helical, spring type, ASME B18.21.1.

H. Post-Installed Anchors: chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   1. Material for all Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.6 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

   1. Join components by welding unless otherwise indicated.
   2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.7 STEEL-FRAMED STAIRS

A. Stair Framing:

1. Fabricate stringers of steel as indicated in the drawings.

    a. Provide closures for exposed ends of tube stringers.

2. Construct platforms of steel as indicated in the drawings. Headers and miscellaneous framing members as indicated in the drawings.
3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.

B. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness indicated.

1. Steel Sheet: Uncoated hot-rolled steel sheet unless otherwise indicated.
2. Directly weld risers and treads to stringers; locate welds on underside of stairs.
3. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
4. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
1. Fabricate treads and platforms from welded steel grating with openings in gratings no more than 1/4” in least dimension.
2. Surface: Serrated.

3. Finish: Galvanized.
4. Riser Plates: Rolled-steel (painted), thickness as indicated on drawings.
5. Fabricate grating treads with cast abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
6. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.8 STAIR RAILINGS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."
   1. Rails may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
   2. Connect posts to stair framing by direct welding unless otherwise indicated.

2.9 FINISHES

A. Prep, prime and finish metal stairs per Section 099600 “High Performance Coatings”.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

3.2 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonmetallic, nonshrink grout unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099600 "High-Performance Coatings."

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055100

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Steel railings.
2. Stainless-steel pipe railings.
3. Incorporated systems, gates, sign frames, brackets and fasteners

1.3 PERFORMANCE REQUIREMENTS

A. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

1. Steel: 60 percent of minimum yield strength.
2. Stainless Steel: 60 percent of minimum yield strength.

B. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. applied in any direction.
b. Concentrated load of 200 lbf applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout, anchoring cement, and paint products.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Samples for Verification: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

C. Welding certificates.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.8 COORDINATION AND SCHEDULING

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.9 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.2 STEEL AND IRON

A. Tubing: ASTM A 500 (cold formed) or ASTM A 513.

B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.3 STAINLESS STEEL

A. Tubing: ASTM A 554, Grade MT 316L.

B. Pipe: ASTM A 312/A 312M, Grade TP 316L Extra Strong.

C. Castings: ASTM A 743/A 743M, Grade CF 8M or CF 3M.

D. Plate and Sheet: ASTM A 240/A 240M or ASTM A 666, Type 316L.

E. Handrail Brackets: Provide stainless steel post-mount handrail brackets capable of mechanical attachment to posts.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Wagner, R & B, Inc.; a division of the Wagner Companies (Model # MB3302P)
      b. Approved Equal.

2.4 FASTENERS

A. General: Provide the following:
   1. Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 for zinc coating.
   2. Stainless-Steel Railings: Type 316 stainless-steel fasteners.

B. Post-Installed Anchors: chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   1. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

   1. For stainless-steel railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Shop Primers: Provide primers that comply with Section 099600 "High-Performance Coatings."

C. Intermediate Coats and Topcoats: Provide products that comply with Section 099600 "High-Performance Coatings."

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with welded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

J. Form changes in direction as follows:

1. As detailed.

K. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of railing members with prefabricated end fittings.

M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.8 STEEL AND IRON FINISHES

A. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry, unless otherwise noted on drawings.

1. Preparation for Shop Priming: Surface Preparation for Exterior Exposed Structural Steel: Systems include exterior platform railings and incorporated systems, gates, sign frames, brackets and fasteners. Prepare steel to SSPC-SP 10 "Near White Blast Cleaning," and to the requirements listed in Section 099600 – “High Performance Coatings”.

B. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Shop prime uncoated railings with primers specified in Section 099600 "High-Performance Coatings”.

C. Shop-Painted Finish: Comply with Section 099600 "High-Performance Coatings."

1. High-Performance Coating: Apply coatings as specified in Section 099600 "High-Performance Coatings”.

2.9 STAINLESS-STEEL FINISHES

A. Remove tool and die marks and stretch lines, or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Directional Satin Finish: No. 4.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.3 ANCHORING POSTS

A. Anchor posts to surfaces with flanges connected to posts and to supporting members as follows:
1. For stainless-steel pipe railings, weld flanges to post and bolt to supporting surfaces.

2. For steel pipe railings, weld flanges to post and bolt to supporting surfaces.

3.4 ADJUSTING AND CLEANING

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099600 "High-Performance Coatings."

3.5 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

SECTION 055300 - METAL GRATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Metal bar gratings.
2. Metal frames and supports for gratings.

B. Related Sections:
1. Section 033000 “Cast-In-Place Concrete”
2. Section 034100 “Precast Structural Concrete”
3. Section 051200 “Structural Steel Framing” for structural-steel framing system components.
4. Section 055100 "Metal Stairs" for grating treads and landings of steel-framed stairs (Hartford Station).

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Floors: Uniform load of 125 lbf/sq. ft. or concentrated load of 2000 lbf, whichever produces the greater stress.
2. Limit deflection to L/240 or 1/4 inch, whichever is less.

B. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For the following:

1. Formed-metal plank gratings.
2. Clips and anchorage devices for gratings.

C. Shop Drawings: Include plans, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3, "Structural Welding Code - Sheet Steel."
4. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

C. Wire Rod for Bar Grating Crossbars: ASTM A 510.

D. Uncoated Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30.

E. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33, with G90 coating.

F. Expanded-Metal Carbon Steel: ASTM F 1267, Class 1.

G. Expanded-Metal Galvanized Steel: ASTM F 1267, Class 2, Grade A.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

2.3 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Welding: Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

2.5 METAL BAR GRATINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. All American Grating, Inc.
2. Tru-Weld.
3. McNichols Co. – Wheels and Heals (Basis of Design)

B. Welded Steel Grating:

1. Bearing Bar Spacing: 1/2 inch.
2. Bearing Bar Depth: 2 inches
3. Bearing Bar Thickness: 1/4 inch.
4. Crossbar Spacing: 4 inches
5. Traffic Surface: Applied abrasive finish consisting of aluminum-oxide aggregate in an epoxy-resin adhesive.
6. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. of coated surface.

2.6 GRATING FRAMES AND SUPPORTS

A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.

B. Galvanize all steel frames and supports.

2.7 STEEL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish gratings, frames, and supports after assembly.

C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

3.2 INSTALLING METAL BAR GRATINGS

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055300

SECTION 055813 - COLUMN COVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes snap-together metal column covers.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product, including finishing materials.

C. Shop Drawings: Show fabrication and installation details for column covers.

D. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.

E. Samples for Verification: For each type of exposed finish required, prepared on 6-inch- (150-mm-) square Samples of metal of same thickness and material indicated for the Work.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For [fabricator] [organic-coating applicator] [anodic finisher] [and] [powder-coating applicator].

C. Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

B. Maintenance Data: For [mirrorlike stainless-steel finish] [and] [statuary conversion coating copper-alloy finish] to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Fabricator Qualifications: A firm experienced in producing column covers similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

D. Anodic Finisher Qualifications: A firm experienced in successfully applying anodic finishes of type indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

E. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated to metals of types indicated and that employs competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.

F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Build mockups of typical column covers.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver column covers wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

PART 2 - PRODUCTS

2.1 SNAP-TOGETHER COLUMN COVERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ATAS International, Inc.
2. Fry Reglet Corporation.
3. MM Systems Corporation.
4. Pittcon Industries.

B. Form column covers to shapes indicated from metal of type and minimum thickness indicated below. Return vertical edges and bend to form hook that engages continuous mounting clips.

1. Column covers may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
2. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide flat surfaces where indicated.
3. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
4. Form returns at vertical joints to provide hairline V-joints.
5. Form returns at vertical joints to provide 1/2-inch wide reveal at joints. Provide snap-in metal filler strips at reveals that leave reveals 1/2 inch flush.
6. Form returns at vertical joints to accommodate backer rod and sealant.
7. Fabricate column covers with hairline horizontal V-joints produced by forming returns on mating ends of column cover sections. Locate horizontal joints as indicated.
8. Fabricate column covers without horizontal joints.
9. Fabricate column covers with horizontal butt joints, tightly fitted and backed with a sleeve for field splicing with adhesive.
10. Fabricate column covers with 0-inch wide reveals at horizontal joints produced by forming returns on mating ends of column cover sections. Provide snap-in metal filler strips at reveals matching reveals at vertical joints. Locate horizontal joints as indicated.
11. Fabricate base ceiling ring to match column covers.
12. Fabricate with calk stop/stiffener ring.
13. Apply manufacturer's recommended sound-deadening mastic to backs of column covers.

2.2 MISCELLANEOUS MATERIALS

A. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.

1. Provide concealed fasteners for interconnecting column covers and for attaching them to other work unless exposed fasteners are unavoidable.
2. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

B. Sound-Deadening Materials:

1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C 665, Type I, and passing ASTM E 136 test.
2. Mastic: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

C. Backing Materials: Provided or recommended by column cover manufacturer.

2.3 PAINTS AND COATINGS

A. Low-Emitting Materials: Paints and coatings applied to interior decorative formed metal items shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Lacquer for Copper Alloys: Clear, acrylic lacquer specially developed for coating copper-alloy products.

C. Shop Primers: Comply with Section 099600 "High-Performance Coatings."

D. Universal Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.4 FABRICATION, GENERAL

A. Coordinate dimensions and attachment methods of column covers with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.

B. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends.

2.5 GENERAL FINISH REQUIREMENTS

A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: Match as indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of column covers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Locate and place column covers plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install column covers.

1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

B. Use concealed anchorages where possible.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

E. Apply joint treatment at joints of spackled-seam metal column covers. Comply with requirements in Section 092900 "Gypsum Board."

3.3 ADJUSTING AND CLEANING

A. Clean copper alloys according to metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.

B. Touchup Painting: Immediately after erection, clean abraded areas of shop paint and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

C. Touchup Painting: Cleaning and touchup painting of shop paint are specified in Section 099600 "High-Performance Coatings."

D. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

3.4 PROTECTION

A. Protect finishes from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

END OF SECTION 055813

SECTION 057500 - DECORATIVE FORMED METAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Platform steel column closures and trim.
2. Entry ramp steel column closures and trim.

B. Related Sections:

1. Section 051200, "Structural Steel Framing"

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated. Include finishing materials.

C. Shop Drawings: Show fabrication and installation details for decorative formed metal.

1. Include plans, elevations, component details, and attachments to other work.
2. Indicate materials and profiles of each decorative formed metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.

D. Samples: For each type of exposed finish required, prepared on 6-inch- square Samples of metal of same thickness and material indicated for the Work.

PART 2 - PRODUCTS

2.1 SHEET METAL

A. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections where exposed to view on finished units.

B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

2.2 MISCELLANEOUS MATERIALS

A. Gaskets: As required to seal joints in decorative formed metal and remain weathertight; as recommended in writing by decorative formed metal manufacturer.

B. Sealants, Exterior: ASTM C 920; elastomeric polyurethane or polysulfidesealant; of type, grade, class, and use classifications required to seal joints in decorative formed metal and remain weathertight; and as recommended in writing by decorative formed metal manufacturer.

C. Filler Metal and Electrodes: Provide type and alloy as necessary for strength, corrosion resistance, and compatibility in fabricated items.

1. Use filler metals that will match the color of metal being joined.

D. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated.

1. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

E. Anchors: Provide metal expansion sleeve anchors or metal-impact expansion anchors of type, size, and material necessary for type of load and installation indicated, as recommended by manufacturer, unless otherwise indicated.

1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

F. Isolation Coating: Manufacturer's standard bituminous paint.

2.3 PAINTS AND COATINGS

A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

B. Shop Primers: Comply with Section 099600 "High-Performance Coatings."

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble decorative formed metal items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Fold back exposed edges of unsupported sheet metal to form a 1/2-inch- wide hem on the concealed side, or ease edges to a radius of approximately 1/32 inch and support with concealed stiffeners.

C. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide surface flatness and sufficient strength for indicated use.

1. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

D. Where welding or brazing is indicated, weld or braze joints and seams continuously. Grind, fill, and dress to produce smooth, flush, exposed surfaces in which joints are not visible after finishing is completed.

2.5 CLOSURES AND TRIM

A. Form closures and trim from metal of type and thickness indicated below. Fabricate to fit tightly to adjoining construction, with weathertight joints at exterior installations.

1. Galvanized-Steel Sheet: 0.052 inch .

a. Finish: Powder coat.

b. GENERAL FINISH REQUIREMENTS

B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.6 GALVANIZED-STEEL SHEET FINISHES

A. Preparing Galvanized Items for Factory Priming: Thoroughly clean galvanized decorative formed metal of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

B. Preparing Galvanized Items for Factory Finishing: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

C. Repairing Galvanized Surfaces: Clean welds and abraded areas and repair galvanizing to comply with ASTM A 780.

D. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils.

2.7 STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning." Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or with SSPC-SP 8.

B. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.

C. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply shop primer to prepared surfaces of items unless otherwise indicated.

D. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane powder coating with cured-film thickness not less than 1.5 mils.

2.8 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Directional Satin Finish: No. 4.

C. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and place decorative formed metal items level and plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install decorative formed metal.

B. Use concealed anchorages where possible.

C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.

D. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

E. Install decorative-formed-metal-clad doors and frames to comply with requirements specified in Section 081113 "Hollow Metal Doors and Frames."

F. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION 057500

SECTION 061063 - EXTERIOR ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Wood soffits.
2. Miscellaneous wood nailers, furring and blocking
3. Framing with dimensional lumber.

1.3 DEFINITIONS

A. Boards: Lumber of less than 2 inches nominal in thickness and 2 inches nominal or greater width.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

C. Timber: Lumber of 5 inches nominal or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Material Certificates:
   1. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

C. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

C. Handle and store plastic lumber to comply with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 LUMBER, GENERAL

A. Lumber: Comply with DOC PS 20 and with applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by ALSC's Board of Review. Provide lumber graded by an agency certified by ALSC's Board of Review to inspect and grade lumber under the rules indicated.

   1. Factory mark each item with grade stamp of grading agency.
   2. For items that are exposed to view in the completed Work, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
   3. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 DIMENSION LUMBER

A. Maximum Moisture Content: 15 percent for 2-inch nominal thickness or less; 19 percent for more than 2-inch nominal thickness.

B. Exposed soffit: Provide material hand selected for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane, the following grade, species, and sizes:

1. Grade; Select Structural.
2. Doug Fir-Larch; WWPA.
3. Sizes; as indicated on plans.

2.3 SOFFIT BOARDS

A. Provide Fire-Retardant Treaded soffit boards to meet the following.

B. Maximum Moisture Content: 15 percent.

C. Provide boards hand selected for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane.

D. Soffit Boards: Tongue and groove V-groove roof deck boards, sized as shown on plans. Provide material hand selected for freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot holes, shake, splits, torn grain, and wane, the following grade, species, and sizes:

1. Grade; Select Structural.
2. Southern pine; SPIB.
3. Sizes; as indicated on plans.

2.4 PRESERVATIVE TREATMENT

A. Pressure treat boards and dimension lumber with waterborne preservative according to AWPA C2.

B. Pressure treat timber with waterborne preservative according to AWPA C15 requirements for "sawn building poles and posts as structural members."

C. Preservative Chemicals: Acceptable to authorities having jurisdiction.

1. Do not use chemicals containing arsenic or chromium.

D. Use process that includes water-repellent treatment.

E. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.

F. After treatment, redry dimension lumber to 19 percent maximum moisture content.

G. Mark treated wood with treatment quality mark of an inspection agency approved by ALSC's Board of Review.

1. For items indicated to receive a stained or natural finish, mark each piece on surface that will not be exposed or omit marking and provide certificates of treatment compliance issued by inspection agency.

H. Application: Treat items indicated on Drawings and the following:

1. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

2.5 FIRE-RETARDANT-TREATED MATERIALS

A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

1. Use treated materials that comply with requirements of referenced woodworking standard. Do not use materials that are warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.

B. Fire-Retardant-Treated Lumber: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. For all applications, use materials that comply with testing requirements after being subjected to accelerated weathering according to ASTM D 2898.
2. Kiln dry lumber after treatment to a maximum moisture content of 19 percent.
3. All wood items are to receive a stained or natural finish. Use organic resin chemical formulation on all wood.
4. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking shop certified by testing and inspecting agency.
5. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.

1. Use stainless steel unless otherwise indicated.
2. For pressure-preservative-treated wood, use stainless-steel fasteners.

B. Wood Screws: ASME B18.6.1.

C. Stainless-Steel Bolts: ASTM F 593, Alloy Group 1 or 2; with ASTM F 594, Alloy Group 1 or 2 hex nuts and, where indicated, flat washers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Prime lumber to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Section 099113 "Exterior Painting."

3.3 INSTALLATION, GENERAL

A. Set exterior rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit exterior rough carpentry to other construction; scribe and cope as needed for accurate fit.

B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction" unless otherwise indicated.

C. Install wood rafters with crown up.

D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

E. Secure decking to framing in a manner which conceals fasteners.

F. Do not splice structural members between supports unless otherwise indicated.

G. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

H. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

I. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron (SBX) for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

J. Securely attach exterior rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

K. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

END OF SECTION 061063

SECTION 061600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Roof sheathing.
3. Underlayment.
4. Sheathing joint and penetration treatment.

B. Related Requirements:

1. Section 061063, "Rough Carpentry" for plywood backing panels.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Evaluation Reports: For following products, from ICC-ES:

1. Preservative-treated plywood.
2. Fire-retardant-treated plywood.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory**.**".
2. Retain "Emissions" Paragraph below if required for LEED for Schools Credit IEQ 4.

2.2 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction, Use Category UC3b for exterior construction.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.3 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

3. Design Value Adjustment Factors: Treated lumber plywood shall be tested according ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat all plywood unless otherwise indicated

2.4 WALL SHEATHING

A. Glass-Mat Gypsum Wall Sheathing: ASTM C 1177/1177M.

1. Products: Subject to compliance with requirements, provide products by one of the following:

   a. CertainTeed Corporation; GlasRoc.
   b. G-P Gypsum Corporation; Dens-Glass Gold.
   c. National Gypsum Company; Gold Bond e(2)XP.
   d. Temple-Inland Inc.; GreenGlass
   e. United States Gypsum Co.; Securock.

2. Type and Thickness: Type X, 5/8 inch thick.

B. Cementitious Backer Units: ASTM C 1325, Type A.

1. Products: Subject to compliance with requirements, provide products by one of the following:

   a. C-Cure; C-Cure Board 990.
   b. Custom Building Products; Wonderboard.
   c. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
   d. USG Corporation; DUROCK Cement Board.

2. Thickness: 5/8 inch.

2.5 ROOF SHEATHING

A. Plywood Roof Sheathing: Exterior, Structural I sheathing as substrate board beneath standing seam metal roofing.

1. Span Rating: Not less than 16/0.
2. Nominal Thickness: Not less than 3/4 inch.

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For roof and wall sheathing, provide fasteners of Type 304 stainless steel.

2.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C 834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch, of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

2.8 MISCELLANEOUS MATERIALS

A. Adhesives for Field Gluing Panels to Framing: Formulation complying with APA AFG-01 and ASTM D 3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."

D. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:

1. Wall and Roof Sheathing:
    a. Screw to cold-formed metal framing.
    b. Space panels 1/8 inch apart at edges and ends.

3.3 GYPSUM SHEATHING INSTALLATION

A. Comply with GA-253 and with manufacturer's written instructions.

1. Fasten gypsum sheathing to wood framing with screws.
2. Fasten gypsum sheathing to cold-formed metal framing with screws.
3. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
4. Install boards with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.

B. Seal sheathing joints according to sheathing manufacturer's written instructions.

1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel silicone emulsion sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.

END OF SECTION 061600

SECTION 061813 - GLUED-LAMINATED BEAMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes:

1. Framing using structural glued-laminated timber.

B. Related Sections:

1. Section 05400 "Cold-Formed Metal Framing".
2. Section 061063 "Exterior Rough Carpentry".

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Shop Drawings: Submit Shop Drawings for glued laminated members.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Certificates of Conformance: Issued by a qualified testing and inspecting agency indicating that structural glued-laminated timber complies with requirements in AITC A190.1.

1.5 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer Qualifications: An AITC- or APA-EWS-licensed firm.

C. Comply with the following as a minimum requirement:

1. AITC 117 – Structural Glued Laminated Timber of Softwood Species.
2. ASTM D3737 – Design and Manufacture of Structural Glued Laminated Timber.
3. ANSI/AITC A190.1 – Standard Specifications for Glued Laminated Timber.
4. WCLIB – Standard Grading and Dressing Rules.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with provisions in AITC 111.

B. After fabrication and prior to shipping, seal surfaces of each member, including ends, with two coats of sealer primer, installed in accordance with manufacturer's written recommendations.

C. Each member, which will be exposed in completed structure, shall be separately wrapped in heavy waterproof paper for protection against weather and damage in shipping and handling. Do not remove wrapping until after members have been installed. Protect all members from damage, whether concealed or exposed in the finished Work.

D. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 STRUCTURAL GLUED-LAMINATED TIMBER

A. General: Provide structural glued-laminated timber that complies with AITC A190.1 and AITC 117 or research/evaluation reports acceptable to authorities having jurisdiction.

1. Factory mark each piece of structural glued-laminated timber with AITC Quality Mark or APA-EWS trademark. Place mark on surfaces that are not exposed in the completed Work.

2. Provide structural glued-laminated timber made with wet-use adhesive complying with AITC A190.1.
3. Adhesive shall not contain urea-formaldehyde resins.
4. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Species and Grades for Structural Glued-Laminated Timber: Any species that complies with fire resistance and beam stress classifications as indicated on the contract plans.

C. Appearance Grade: Appearance grade of member shall be Architectural grade, complying with AITC 110.

2.3 TIMBER CONNECTORS

A. Timber connectors shall be fabricated according to the contract plans.

B. Hot-dip galvanize steel assemblies and fasteners after fabrication to comply with ASTM A 123/A 123M or ASTM A 153/A 153M.

2.4 MISCELLANEOUS MATERIALS

A. Lumber for Laminating: Conforming to the structural requirements and laminating specifications of AITC 117, of stress grades and combination indicated that provides glued laminated members with allowable stress values in bending as indicated.

B. Glue: Exterior type; waterproof.

C. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

D. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

E. Sealers shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 FABRICATION

A. Appearance grade of members shall be Industrial Grade where concealed and Architectural Grade where exposed.

B. Weather exposed surfaces of members shall be protected to prevent decay. When member is protected with pressure treatment, treatment process shall not impair

structural integrity of member. When member is protected by flashing or is encased, provide ventilation and prevent moisture entrapment on member.

C. Joints: End joints in adjacent laminations shall be separated. Joints in adjacent laminations of arched members shall be separated as required for bending members.

D. Maximum moisture content of the wood at time of gluing shall not exceed 16 percent for Projects located in coastal areas, 12 percent for Projects located in interior valleys or 10 percent for Projects located in desert areas, with geographical areas determined by DSA. Moisture content of wood for members that will be exposed to direct sunlight in finished structure shall not exceed 10 percent at time of gluing. Range of moisture content of laminations assembled into a single member shall not exceed 5 percent at time of gluing.

E. Reinforcement for Radial Tension: Where mechanical reinforcement is required to resist radial tension, reinforcement shall be as described in the Timber Construction Manual. Maximum spacing of mechanical reinforcement shall not exceed half effective depth of member at location of reinforcement.

F. Notches: Notched glued laminated members shall be designed as required for sawn lumber using allowable stress of a combination, with outer lamination being grade of laminations exposed by notch. Where a notch is located on tension face of a member, at least one fully-threaded lag bolt, or equal, shall be provided on each side of notch to prevent splitting.

G. Fabricate and assemble components for laminations in combinations in accordance with requirements of AITC 117 and ASTM D3737.

H. Shop fabricate for connections to greatest extent possible, including cutting to length and drilling bolt holes.

I. Camber: Fabricate horizontal and inclined members of less than 1:1 slope with either circular or parabolic camber equal to 1/500 of span.

J. End-Cut Sealing: Immediately after end cutting each member to final length, apply a saturation coat of end sealer to ends and other cross-cut surfaces, keeping surfaces flood coated for not less than 10 minutes.

K. Seal Coat: After fabricating, sanding, and end-coat sealing, apply a heavy saturation coat of penetrating sealer on surfaces of each unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Erect structural glued-laminated timber true and plumb and with uniform, close-fitting joints. Provide temporary bracing to maintain lines and levels until permanent supporting members are in place.

1. Provide erection bracing in addition to required lateral bridging. Avoid temporary construction loads in excess of design limits. Maintain members straight and plumb. Provide adequate lateral support for individual members and entire system until permanent bridging and sheathing is installed. Deliver and erect each member in one piece. Field splicing is not permitted unless reviewed by the Architect.
2. Handle and temporarily support glued-laminated timber to prevent surface damage, compression, and other effects that might interfere with indicated finish.

B. Cutting: Avoid extra cutting after fabrication. Where field fitting is unavoidable, comply with requirements for shop fabrication.

C. Fit structural glued-laminated timber by cutting and restoring exposed surfaces to match specified surfacing.

1. Predrill for fasteners using timber connectors as templates.
2. Finish exposed surfaces to remove planing or surfacing marks.
3. Coat cross cuts with end sealer.

3.2 ADJUSTING

A. Repair damaged surfaces after completing erection. Replace damaged structural glued-laminated timber if repairs are not approved by Architect.

3.3 CLEANUP

A. Remove debris, rubbish and waste material and legally dispose of off the Project site.

3.4 PROTECTION

A. Do not remove wrappings on individually wrapped members until they no longer serve a useful purpose, including protection from weather, sunlight, soiling, and damage from work of other trades.

1. Slit underside of wrapping to prevent accumulation of moisture inside the wrapping.

END OF SECTION 061800

SECTION 066400 - POLYETHYLENE PLATFORM EDGE STRIPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Polyethylene Platform Edge Strips

B. Related Sections:

1. Section 033000 "Cast-In-Place Concrete"
2. Section 034100 “Precast Structural Concrete”
3. Section 035300 “Concrete Topping”

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Submit product data for review and approval.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01

B. The coefficient of thermal expansion in degrees Fahrenheit, tested in accordance with ASTM D696, shall not be greater than:

1. 0 to 75 degrees: 1.1×10^{-4} inches per inch
2. 75 to 120 degrees: 1.87×10^{-4} inches per inch

C. Fabrication Tolerances:

1. The straightness tolerance on the concrete edge side of the rubbing board shall be 1/8 inch in a sixteen foot section.
2. The variation in width of the board shall not be more than 1/16 of an inch in any length section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Handle and store in compliance with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 POLYETHYLENE PLATFORM EDGE STRIPS

A. Size and shape shall be as indicated on the Contract Drawings. The platform edge strip shall be yellow colored, UV stable, ultra high molecular weight polyethylene profile. The top surface shall be crosshatched to create a non-slip surface.

1. Basis-of-Design Product: Subject to compliance with requirements, provide SP-S-26 by Engineered Plastics Inc., 300 International Dr., Williamsville, NY 14221, Tel: 800-682-2525, or approved equal.
2. Fasteners shall be stainless steel and corrosion proof.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION, GENERAL

A. The Contractor shall gauge the concrete edge of the platform with the center line of track and dress the platform edge to provide the proper train clearance as follows:

If the centerline of the track is on a curve, this clearance shall be increased by the amount of "end" or "center" excesses, according to the Amtrak car clearance standard, unless other instructions are given on the Contract Drawings.

B. Attach polyethylene platform edge strips after precast platforms have been erected and properly leveled and back-sloped.

C. Attach polyethylene platform edge strips to precast concrete platforms with approved stainless steel, corrosion proof fasteners.

END OF SECTION 061063

SECTION 071113 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Hot-applied asphalt dampproofing.
2. Cold-applied, cut-back-asphalt dampproofing.
3. Cold-applied, emulsified-asphalt dampproofing.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1.4 INFORMATION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide protection course molded-sheet drainage panels and auxiliary materials recommended in writing by manufacturer of primary materials.

B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.2 HOT-APPLIED ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Owens Corning Roofing and Asphalt, LLC; Trumbull Division.

B. Hot-Applied Asphalt: ASTM D 449, Type II.

2.3 COLD-APPLIED, CUT-BACK-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. APOC, Inc.; a division of Gardner-Gibson.
2. BASF Construction Chemicals - Building Systems; Sonneborn Brand Products.
3. Brewer Company (The).
4. ChemMasters, Inc.
5. Euclid Chemical Company (The); an RPM company.
6. Henry Company.
7. Karnak Corporation.
8. Koppers Inc.
9. Malarkey Roofing Products.
10. Meadows, W. R., Inc.

B. Trowel Coats: ASTM D 4586, Type I, Class 1, fibered.

C. Brush and Spray Coats: ASTM D 4479, Type I, fibered or nonfibered.

2.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. APOC, Inc.; a division of Gardner-Gibson.
2. BASF Construction Chemicals - Building Systems; Sonneborn Brand Products.
3. Brewer Company (The).
4. ChemMasters, Inc.
5. Euclid Chemical Company (The); an RPM company.
6. Gardner-Gibson, Inc.
7. Henry Company.
8. Karnak Corporation.
9. Koppers Inc.
10. Malarkey Roofing Products.
11. Meadows, W. R., Inc.

B. Trowel Coats: ASTM D 1227, Type II, Class 1.

C. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

D. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

2.5 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D 41.

C. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

1. Primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

E. Patching Compound: Epoxy or latex-modified repair mortar of type recommended in writing by dampproofing manufacturer.

F. Protection Course: Extruded-polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch thick.

2.6 MOLDED-SHEET DRAINAGE PANELS

A. Molded-Sheet Drainage Panel: Comply with Section 334600 "Subdrainage."

B. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 sieve laminated to one side of the core; and with a vertical flow rate of 9 to 15 gpm per ft..

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. American Hydrotech, Inc.
b. Carlisle Coatings & Waterproofing Inc.
c. Grace, W. R., & Co. - Conn.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting performance of bituminous dampproofing work.

1. Test for surface moisture according to ASTM D 4263.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.

C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for substrate preparation, dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.

1. Apply dampproofing to provide continuous plane of protection.
2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.

1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.

3.4 HOT-APPLIED ASPHALT DAMPPROOFING

A. Do not apply hot asphalt when substrate condition causes foaming.

B. Kettle Temperature: Comply with dampproofing-material manufacturer's written instructions, and keep at least 25 deg F below the flash point.

C. Prime masonry and other porous substrates.

D. Apply a uniform coat of hot asphalt by mopping or spraying at not less than 20 lb or 2.5 gal./100 sq. ft..

1. Apply a second coat to below-grade foundation walls and where first application has failed to produce a smooth surface and uninterrupted coverage. Apply second coat at the rate specified for first coat.

3.5 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat.

B. Unexposed Face of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.25 gal./100 sq. ft..

C. Concrete Backup for Precast Veneer Cladding: Apply one brush or spray coat at not less than 1 gal./100 sq. ft..

D. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft.

E. Interior Face of Exterior Concrete Walls: Where above grade and indicated to be furred and finished, apply one brush or spray coat at not less than 1 gal./100 sq. ft..

3.6 INSTALLATION OF PROTECTION COURSE

A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.
   1. Install protection course on same day of installation of dampproofing (while coating is tacky) to ensure adhesion.

3.7 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall substrate, according to manufacturer's written instructions. Use adhesives or other methods that do not penetrate dampproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

   1. Install protection course before installing drainage panels.

3.8 CLEANING

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071113

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:
1. Glass-fiber blanket insulation.
2. Spray polyurethane foam insulation.
3. Vapor retarders.
4. Insulation fasteners

1.3 RELATED SECTIONS

A. Refer to Section 034100 "Precast Structural Concrete".

B. Refer to Section 054000 "Cold-Formed Metal Framing".

C. Refer to Section 092216 "Non-Structural Metal Framing".

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product test reports.

C. Research/evaluation reports.

D. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.6 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage, mixing with other components, and application.

C. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

D. Protect pre-installed insulation from damage during delivery, storage and handling to the satisfaction of the Engineer.

E. Deliver spray foam product with expiration dates clearly visible for inspection.

F. Spray Foam Installers: Only use personnel licensed or approved by the spray foam manufacturers own Quality and Training Program.

1.8 MOCK-UP

A. Create a sample of spray foam insulation for review and approval, 25-square feet minimum in size on the surface which it will be applied, to test adhesion and finished appearance of the product. Notify the Engineer and the Designer that the mockup is complete and ready for review and approval at least five days prior to beginning the full installation. This sample may be part of the completed structure.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION FOR UNDER-SLAB INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. DiversiFoam Products.
    b. Dow Chemical Company (The).
    c. Owens Corning.
2. Type IV, 25 psi for CAVITY WALLS
3. Type V, 100 psi for UNDERSLAB INSULATION

B. Unfaced Wall Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type IV, 25-psi or Type VI, 40-psi minimum compressive strength; unfaced; fabricated with shiplap or channel edges and with one side having grooved drainage channels.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. DiversiFoam Products.
    b. Dow Chemical Company (The).
    c. Pactiv Building Products.

2.2 GLASS-FIBER BLANKET INSULATION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CertainTeed Corporation.
2. Guardian Building Products, Inc.
3. Johns Manville.
4. Owens Corning.

B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

2.3 SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

B. Properties:
1. Density (ASTM D-1622) minimum = 1.9 lb/ft.3
2. Compressive strength (ASTM D-1621), parallel to rise (10% compression) = 32 psi.
3. R-value of 6 to 6.5 per inch.
4. Tensile strength (ASTM D-1623) = 49 psi
5. Open cell content (ASTM D-2856) = <1%
6. Water absorption (ASTM D-2842) % by volume = 2.5%
7. Dimensional stability (ASTM D-2126), % volume change after 28 days: 4°F = 0.047%, 212°F = 8.45%, 158°F with relative humidity >90±3% = 7.64%

8. Water vapour permeance (ASTM E-96), without the skins, core only = 125 ng/Pa.s.m²
9. Flame spread classification = 375
10. Smoke determined = 288
11. VOC results during the curing period were below the detectable limit after 24 hrs

12. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. BASF Corporation.
    b. Dow Chemical Company (The).
    c. ERSystems, Inc.

13. Minimum density of 1.5 lb/cu. ft., thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.4 VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils thick, with maximum permeance rating of 0.13 perm.

B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.5 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
    b. Gemco; Spindle Type.

2. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Gemco; 90-Degree Insulation Hangers.

2. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. AGM Industries, Inc.; RC150 or SC150.
b. Gemco; Dome-Cap R-150 or S-150.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.2 EXAMINATION

A. Examine substrates, with Installer present, for conditions affecting performance of concrete overlay.

B. Notify Engineer in writing of circumstances detrimental to the proper completion of the work.

C. Proceed with application only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

A. On vertical surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.

1. If not otherwise indicated, extend insulation a minimum of 24 inches below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

1. If not otherwise indicated, extend insulation a minimum of 24 inches in from exterior walls.

3.4 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

C. Spray-Applied Insulation for Framed Construction: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

D. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.5 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

A. Board Insulation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.

3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

B. Spray Foam Insulation: Install spray foam insulation on concrete substrates as follows:
1. Install spray foam as specified in ASTM C1029 – 13, Standard Specification for Spray-Applied Rigid Cellular Polyurethane Thermal Insulation.
2. Surfaces must be clean and dry. The substrate must be free of all frost, dust, oil, grease, oxidization, or any other element that may affect adhesion of the system i.e. high moisture content.
3. Polyurethane foam should be sprayed with a tolerance of ¼-inch in relation to the thickness indicated on the plans
4. Ensure the work area is adequately ventilated per the spray foam manufacturer's directions. Ensure continuous and proper ventilation of the work area, through a fresh air intake and the extraction of foul air, during the course of the application process and for 24 hours thereafter.
5. When necessary, install temporary partitions or shields in order to prevent any over spray outside of the work area from the sprayed on insulation material.
6. Protect all adjacent surfaces and equipment against any damage that may be caused by dispersion and over spray of insulation material beyond prescribed limits.
7. Apply insulating material only if the surface and ambient air temperatures are within the manufacturer's prescribed limits, i.e., +14°F to +104°F.
8. Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls and cavities is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.
9. After insulation is applied, make flush with face of studs or formwork by using method recommended by insulation manufacturer.
10. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the manufacturer's recommendations.
11. Construction Joints: If insulation is factory-applied, Install insulation at joints where required to prevent gaps in insulation using the manufacturer's recommendations.
12. Other Subsequent Construction: Where electrical conduits, supports or other subsequent construction damages the foam installation, patch insulation in damaged areas to prevent gaps in insulation using the manufacturer's recommendations.
13. Ensure the subsequent coverage of the applied insulating foam will be completed within the manufacturer's prescribed time frame.
14. NOTE: Field application of the spray insulation under the platform will require coordination with Amtrak regarding track outages and flagmen. The contractor shall pay special attention to the article entitled, "safety and protection of the railroad traffic and property", "requirements for temporary protection shields…" and other Amtrak specifications in the general provisions. As an alternative, the contractor may apply the closed-cell foam polyurethane prior to installation of the precast platform components. If plant-applied insulation is chosen, the contractor shall include installation methods, drawings, material certifications and methods to protect the insulation during delivery, storage and installation, as well as repair methods for damaged insulation within the precast submittals.

3.6 INSTALLATION OF CURTAIN-WALL INSULATION

A. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.

1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

3.7 INSTALLATION OF VAPOR RETARDERS

A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.

1. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.
2. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
3. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.

C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.8 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes:

1. Standing-seam metal roof panels and accessories for attachment
   a. Snap-Joint – Located at stair towers and pedestrian walkway bridge.
   b. Seamed-Joint – Located at elevator towers.
2. Flashing and Trim
3. Sub-framing and furring

B. Related Sections:

1. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.
2. Section 061600 “Sheathing” for plywood roof sheathing protection board.
3. Section 076200 “Sheet Metal Flashing and Trim” for Standing Seam Metal Roof underlayment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

C. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

C. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

D. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

E. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

C. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

D. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. FM Approvals' Listing: Manufacture and install roof-edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-120. Identify materials with FM Approvals' markings.

B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:

1. Wind Loads: As indicated on the structural drawings (sheet S-601).
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class required by wind loads indicated on the structural drawings.

1. Uplift Rating: UL 90.

F. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A- 100.
2. Hail Resistance: MH.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
   1. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1637.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels (Stair and Pedestrian Bridge Roof): Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. CENTRIA Architectural Systems.
      b. Garland Company, Inc. (The)
      c. IMETCO.

   2. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

      a. Thickness: 0.040 inch.
      b. Surface: Smooth, flat finish.
      c. Exterior Finish: Three-coat fluoropolymer.
      d. Color: Match custom color identified in drawings.

   3. Clips: One-piece fixed to accommodate thermal movement.

      a. Material: 0.062-inch- thick, stainless-steel sheet.

   4. Panel Coverage: 16 inches.
   5. Panel Height: 2 3/8” inches.

C. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels (Elevator Hoistway Roof): Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. CENTRIA Architectural Systems.
      b. Garland Company, Inc. (The)
      c. IMETCO.

2. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

    a. Thickness: 0.040 inch.
    b. Surface: Smooth, flat finish.
    c. Exterior Finish: Three-coat fluoropolymer.
    d. Color: Custom color to match Architect's sample.

3. Clips: One-piece fixed to accommodate thermal movement.
    a. Material: 0.062-inch-thick, stainless-steel sheet.

4. Joint Type: Double folded.
5. Panel Coverage 16 inches.
6. Panel Height: 1.5 inches.

2.3 MISCELLANEOUS MATERIALS

A. A.Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

    1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
    2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
    3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

    1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.

C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Aluminum Panels and Accessories:
   1. Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
   1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

      a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

   1. Apply over the entire roof surface.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.4 METAL PANEL INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.
6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:
1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.

2. Do not penetrate underside of roof decking.
3. Install pressure plates at locations indicated in manufacturer's written installation instructions.
4. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
5. Watertight Installation:

a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.

b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

H. Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.16

SECTION 074213.19 - INSULATED METAL WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Foamed-insulation-core metal wall panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that affect metal panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal panel assembly during and after installation.
8. Review procedures for repair of metal panels damaged after installation.
9. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

D. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer.

C. Product Test Reports: For each product, tests performed by a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

B. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical metal panel assembly as shown on Drawings, including corner, supports, attachments, and accessories.
2. Water-Spray Test: Conduct water-spray test of metal panel assembly mockup, testing for water penetration according to AAMA 501.2.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

C. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

D. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

E. Retain strippable protective covering on metal panels during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

C. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 72:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/240 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces..

E. Fire-Test-Response Characteristics: Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Characteristics: Provide materials and construction tested for fire resistance per ASTM E 119.
2. Intermediate-Scale Multistory Fire Test: Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies.
3. Radiant Heat Exposure: No ignition when tested according to NFPA 268.
4. Potential Heat: Acceptable level when tested according to NFPA 259.
5. Surface-Burning Characteristics: Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E 84.

2.2 FOAMED-INSULATION-CORE METAL WALL PANELS

A. General: Provide factory-formed and -assembled metal wall panels fabricated from two metal facing sheets and insulation core foamed in place during fabrication, and with joints between panels designed to form weathertight seals. Include accessories required for weathertight installation.

1. Panel Performance:

a. Flatwise Tensile Strength: 30 psi when tested according to ASTM C 297/C 297M.
b. Humid Aging: Volume increase not greater than 6.0 percent and no delamination or metal corrosion when tested for seven days at 140 deg F and 100 percent relative humidity according to ASTM D 2126.
c. Heat Aging: Volume increase not greater than 2.0 percent and no delamination, surface blistering, or permanent bowing when tested for seven days at 200 deg F according to ASTM D 2126.
d. Cold Aging: Volume decrease not more than 1.0 percent and no delamination, surface blistering, or permanent bowing when tested for seven days at minus 20 deg F according to ASTM D 2126.
e. Fatigue: No evidence of delamination, core cracking, or permanent bowing when tested to a 20-lbf/sq. ft. positive and negative wind load and with deflection of L/180 for 2 million cycles.
f. Autoclave: No delamination when exposed to 2-psi pressure at a temperature of 212 deg F for 2-1/2 hours.

2. Insulation Core: Modified isocyanurate or polyurethane foam using a non-CFC blowing agent, with maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.

    a. Closed-Cell Content: 90 percent when tested according to ASTM D 6226.
    b. Density: 2.0 to 2.6 lb/cu. ft. when tested according to ASTM D 1622.
    c. Compressive Strength: Minimum 20 psi when tested according to ASTM D 1621.
    d. Shear Strength: 26 psi when tested according to ASTM C 273/C 273M.

B. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Basis-of-Design Product: Subject to compliance with requirements, provide CENTRIA Architectural Systems; Formawall Dimension Series Insulated Core Metal Wall Panels (2” Horizontal Flat) or comparable product by one of the following:
    a. IPS - Insulated Panel Systems, an NCI company; Wall Panel.
    b. Kingspan; Series Wall Panel.
    c. MBCI, a division of NCI Building Systems, L.P.; TW-100 Wall Panel.
    d. Metl-Span LLC; Insulated Metal Wall Panel.

2. Aluminum Sheet: Fabricate panel with exterior and interior facings of same material and thickness. Provide facings of aluminum coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

    a. Exposed Coil Coated Finish (All areas unless specified elsewhere):
        1) Surface: Smooth, flat finish.

    b. Exposed Coil-Coated Finishes:
        1) Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
        2) Color: Custom color to match Finish Schedule.

    c. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
    d. Retain "Backer Board" Subparagraph below if required. A backer board provides additional impact resistance.
    e. Backer Board: On back side of exterior facing.
    f. Retain "Snap-on Batten" Subparagraph below if required. A batten is an optional feature with some manufacturers; verify availability.
    g. Panel Coverage: 40 inches nominal.
    h. Panel Thickness: 2.0 inches.
    i. Coordinate R-value in "Thermal-Resistance Value (R-Value)" Subparagraph below with thickness retained in "Panel Thickness" Subparagraph above.
    j. Thermal-Resistance Value (R-Value): R-5 according to ASTM C 1363.

3. Panel Sealants:

a. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal-faced composite wall panels and remain weathertight; and as recommended in writing by panel manufacturer.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M,Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panelsas required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Aluminum Panels and Accessories:

1. Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 INSULATED METAL WALL PANEL INSTALLATION

A. General: Apply continuous ribbon of sealant to panel joint on concealed side of insulated metal wall panels as vapor seal; apply sealant to panel joint on exposed side of panels for weather seal.

1. Fasten foamed-insulation-core metal wall panels to supports with fasteners at each lapped joint at location and spacing and with fasteners recommended by manufacturer.
2. Apply panels and associated items true to line for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.
3. Provide metal-backed washers under heads of exposed fasteners on weather side of insulated metal wall panels.

4. Locate and space exposed fasteners in uniform vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of washer.
5. Provide sealant tape at lapped joints of insulated metal wall panels and between panels and protruding equipment, vents, and accessories.
6. Apply a continuous ribbon of sealant tape to panel side laps and elsewhere as needed to make panels weathertight.
7. Apply snap-on battens to exposed-fastener, insulated-core metal wall panel seams to conceal fasteners.

B. Foamed-Insulation-Core Metal Wall Panels: Fasten metal wall panels to supports with concealed clips at each joint at location and spacing and with fasteners recommended by manufacturer. Fully engage tongue and groove of adjacent panels.

1. Install clips to supports with self-tapping fasteners.

C. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

D. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to achieve waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213.19

SECTION 074243 - COMPOSITE WALL PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the article entitled, “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY “and other Amtrak Specifications in the Contract.

1.2 SUMMARY

A. Section includes metal-faced composite wall panels.

B. Related Sections:

1. Section 054000 "Cold-Formed Metal Framing" for cold-formed metal framing supporting metal-faced composite wall panels.
2. Section 076200 "Sheet Metal Flashing and Trim" for field-formed flashings and other sheet metal work not part of metal-faced composite wall panel assemblies.

1.3 DEFINITION

A. Metal-Faced Composite Wall Panel Assembly: Metal-faced composite wall panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight wall system.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Metal-faced composite wall panel assemblies shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.

B. Delegated Design: Design metal-faced composite wall panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

D. Water Penetration Under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:

1. Test-Pressure Difference: 6.24 lbf/sq. ft..

E. Structural Performance: Provide metal-faced composite wall panel assemblies capable of withstanding the effects of the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:

1. Wind Loads: Determine loads based on the following minimum design wind pressures:

a. Uniform pressure of 20 lbf/sq. ft., acting inward or outward.
b. Uniform pressure as indicated on Drawings.

2. Deflection Limits: Metal-faced composite wall panel assemblies shall withstand wind loads with horizontal deflections no greater than 1/175 of the span at the perimeter and 1/60 of the span anywhere in the panel.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.5 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal-faced composite wall panel and accessory.

C. Shop Drawings: Show fabrication and installation layouts of metal-faced composite wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish among factory-, shop-, and field-assembled work.

1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

a. Flashing and trim.
b. Anchorage systems.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Metal-Faced Composite Wall Panels: Minimum 12 x 12 inches. Include fasteners, closures, and other metal-faced composite wall panel accessories.

    a. Composite Panels: Include four-way joint.

2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: 12-inch- long Samples for each type of accessory.
4. Exposed Gaskets: 12 inches long.
5. Exposed Sealants: For each type and color of joint sealant required. Install joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of metal-faced composite wall panels adjacent to joint sealants.

E. Delegated-Design Submittal: For metal-faced composite wall panel assembly indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Coordination Drawings: Exterior elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Wall panels and attachments.
2. Stud framing.
3. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
4. Penetrations of wall by pipes and utilities.

C. Qualification Data: For professional engineer.

D. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

F. Warranties: Samples of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

B. Maintenance Data: For metal wall panels to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Owner, Engineer, Designer, Owner's insurer if applicable, testing and inspecting agency representative, metal-faced composite wall panel Installer, metal-faced composite wall panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal-faced composite wall panels including installers of doors, windows, and louvers.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal-faced composite wall panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal-faced composite wall panels.
6. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
7. Review temporary protection requirements for metal-faced composite wall panel assembly during and after installation.
8. Review wall panel observation and repair procedures after metal-faced composite wall panel installation.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver components, sheets, metal-faced composite wall panels, and other manufactured items so as not to be damaged or deformed. Package metal-faced composite wall panels for protection during transportation and handling.

C. Unload, store, and erect metal-faced composite wall panels in a manner to prevent bending, warping, twisting, and surface damage.

D. Store metal-faced composite wall panels vertically, covered with suitable weathertight and ventilated covering. Store metal-faced composite wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal-faced composite wall panels in contact with other materials that might cause staining, denting, or other surface damage. Do not allow storage space to exceed 120 deg F.

E. Retain strippable protective covering on metal-faced composite wall panel for period of panel installation.

1.10 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal-faced composite wall panels to be performed according to manufacturer's written instructions and warranty requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal-faced composite wall panel fabrication and indicate measurements on Shop Drawings.

1.11 COORDINATION

A. Coordinate metal-faced composite wall panel assemblies with rain drainage work, flashing, trim, and construction of studs, soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.12 WARRANTY

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal-faced composite wall panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

C. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal-faced composite wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

A. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alloy as standard with manufacturer, with temper as required to suit forming operations and structural performance required.

1. Surface: Smooth, flat finish.
2. Exposed Coil-Coated Finishes:
   a. Three-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   b. Color: Custom color to match finish schedule.

3. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

B. Panel Sealants:

1. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal-faced composite wall panels and remain weathertight; and as recommended in writing by panel manufacturer.

2.2 MISCELLANEOUS METAL FRAMING

A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G60 hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

B. Subgirts: Manufacturer's standard C- or Z-shaped sections 0.064-inch nominal thickness.

C. Zee Clips: 0.079-inch nominal thickness.

D. Base or Sill Channels: 0.079-inch nominal thickness.

E. Hat-Shaped, Rigid Furring Channels:

1. Nominal Thickness: As required to meet performance requirements.
2. Depth: 1-1/2 inches.

F. Cold-Rolled Furring Channels: Minimum 1/2-inch- wide flange.

1. Nominal Thickness: As required to meet performance requirements.
2. Depth: 3/4 inch.
3. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with nominal thickness of 0.040 inch.

4. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

G. Fasteners for Miscellaneous Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten miscellaneous metal framing members to substrates.

2.3 MISCELLANEOUS MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.

B. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal-faced composite wall panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.

2.4 METAL-FACED COMPOSITE WALL PANELS

A. General: Provide factory-formed and -assembled, metal-faced composite wall panels fabricated from two metal facings bonded, using no glues or adhesives, to solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment system components and accessories required for weathertight system.

1. Fire-Retardant Core: Noncombustible, with the following surface-burning characteristics as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

    a. Flame-Spread Index: 25 or less.
    b. Smoke-Developed Index: 450 or less.

2. Products: Basis-of-Design Product: Subject to compliance with requirements, provide ALPOLIC, Division of Mitsubishi Chemical America, Inc.; ALPOLIC Universe 2000 or comparable product by one of the following:

    a. Alcan Composites USA Inc.; Alucobond Plus.
    b. Alcoa Inc.; Reynobond PE.
    c. CENTRIA Architectural Systems; Formabond Wall System.

B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch- thick, coil-coated aluminum sheet facings.

1. Panel Thickness: 0.197 inch.
2. Core: Fire retardant.
3. Exterior Finish: 3-coat fluoropolymer.

    a. Color: Custom Color to match Finish Schedule

C. Attachment System Components: Formed from material compatible with panel facing.

1. Include manufacturer's standard perimeter extrusions with integral weather stripping, panel stiffeners, panel clips and anchor channels.

2.5 ACCESSORIES

A. Wall Panel Accessories: Provide components required for a complete metal-faced composite wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal-faced composite wall panels unless otherwise indicated.

B. Flashing and Trim: Formed from 0.018-inch- minimum thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal-faced composite wall panels.

2.6 FABRICATION

A. General: Fabricate and finish metal-faced composite wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal-faced composite wall panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.

C. Metal-Faced Composite Wall Panels: Factory form panels in a batch process by laminating each sheet using glues or adhesives between dissimilar materials. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.

1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
2. Fabricate panels with sharply cut edges, with no displacement of face sheets or protrusion of core material.
3. Fabricate panels with panel stiffeners, as required to comply with deflection limits, attached to back of panels with structural silicone sealant or bond tape.
4. Dimensional Tolerances:

    a. Panel Bow: 0.8 percent maximum of panel length or width.
    b. Squareness: 0.25 inch maximum.

D. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal-faced composite wall panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal-faced composite wall panel manufacturer for application, but not less than thickness of metal being secured.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal-faced composite wall panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal-faced composite wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal-faced composite wall panel manufacturer.
3. Verify that weather-resistant sheathing paper has been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal-faced composite wall panels to verify actual locations of penetrations relative to seam locations of panels before panel installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal-faced composite wall panel manufacturer's written instructions.

3.3 METAL-FACED COMPOSITE WALL PANEL INSTALLATION

A. General: Install metal-faced composite wall panels according to manufacturer's written instructions in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts unless otherwise indicated. Anchor panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Commence metal-faced composite wall panel installation and install minimum of 100 sq. ft. in presence of factory-authorized representative.
2. Shim or otherwise plumb substrates receiving metal-faced composite wall panels.
3. Flash and seal metal-faced composite wall panels at perimeter of all openings. Do not begin installation until weather barrier and flashings that will be concealed by panels are installed.
4. Install flashing and trim as metal-faced composite wall panel work proceeds.
5. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
6. Provide weathertight escutcheons for pipe and conduit penetrating exterior walls.

B. Fasteners:

1. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal-faced composite wall panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weathertight performance of metal-faced composite wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by panel manufacturer.

1. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

E. Attachment System Installation, General: Install attachment system required to support metal-faced composite wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.
2. Do not begin installation until weather barrier and flashings that will be concealed by composite panels are installed.

F. Clip Installation: Attach panel clips to supports at each metal-faced composite wall panel joint at locations, spacings, and with fasteners recommended by manufacturer. Attach routed-and-returned flanges of wall panels to panel clips with manufacturer's standard fasteners.

1. Seal horizontal and vertical joints between adjacent panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Section 079200 "Joint Sealants."

3.4 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal-faced composite wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal-faced composite wall panel units within installed tolerance of 1/4 inch in 20 feet, nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Water-Spray Test: After completing the installation of one complete elevator tower assembly of metal-faced composite wall panel, test assembly for water penetration according to AAMA 501.2 in a 2-bay area directed by Architect.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust completed metal-faced composite wall panel installation, including accessories.

C. Metal-faced composite wall panels will be considered defective if they do not pass tests and inspections.

D. Additional tests and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

E. Prepare test and inspection reports.

3.7 CLEANING

A. Remove temporary protective coverings and strippable films, if any, as metal-faced composite wall panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal-faced composite wall panel installation, clean finished surfaces as recommended by panel manufacturer. Maintain in a clean condition during construction.

B. After metal-faced composite wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal-faced composite wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074243

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured reglets with counterflashing.
2. Formed wall sheet metal fabrications.
3. Standing Seam Metal Roof underlayment.

A. Related Sections:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 074113.16 "Standing-Seam Metal Roof Panels" for sloped roofing and associated trim accessories.
3. Section 077100 “ Roof Specialties” for copings, roof-edge flashings on flat roofs, roof-edge drainage systems and counterflashings.
4. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Distinguish between shop- and field-assembled work.
3. Include identification of finish for each item.
4. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

B. Maintenance data.

1.5 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are SPRI ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

1.6 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 SHEET METALS

A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required.
1. (Waiting Area Roof and Curtainwall Trim) Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2. (All Areas unless specified elsewhere) Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 620. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: As selected by Architect from manufacturer's full range

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle Residential, a division of Carlisle Construction Materials; WIP 300HT.
b. Grace Construction Products, a unit of W. R. Grace & Co.-Conn.; Grace Ice and Water Shield HT.
c. Owens Corning; WeatherLock Specialty Tile & Metal Underlayment.

2. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F or higher.
3. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation

and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

G. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 MANUFACTURED REGLETS

A. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory-mitered and -welded corners and junctionsandwith interlocking counterflashing on exterior face, of same metal as reglet.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cheney Flashing Company.
b. Fry Reglet Corporation.
c. Heckmann Building Products, Inc.

2. Material: Aluminum, 0.024 inch thick.
3. Finish: With manufacturer's standard color coating.

2.6 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Obtain field measurements for accurate fit before shop fabrication.
2. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

C. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

F. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

G. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

2.7 WALL SHEET METAL FABRICATIONS

A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch- high, end dams. Fabricate from the following materials:
1. Aluminum: 0.032 inch thick.

B. Wall Expansion-Joint Cover: Fabricate from the following materials:
1. Aluminum: 0.040 inch thick.

PART 3 - EXECUTION

3.1 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
5. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.3 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.4 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION 076200

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Copings.
2. Roof-edge flashings.
3. Roof-edge drainage systems.
4. Counterflashings.

B. Related Sections:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 074113.16 "Standing-Seam Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.
3. Section 074113.23 "Insulated Metal Roof Panels" for roof-edge drainage-system components provided by metal-roof-panel manufacturer.
4. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
5. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. FM Approvals' Listing: Manufacture and install copings and roof-edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-120. Identify materials with FM Approvals' markings.

C. SPRI Wind Design Standard: Manufacture and install copings and roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:

1. Design Pressure: As indicated on Drawings.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Shop Drawings: For roof specialties. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work. Include the following:

1. Details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
2. Pattern of seams and layout of fasteners, cleats, clips, and other attachments.
3. Details of termination points and assemblies, including fixed points.
4. Details of special conditions.

D. Samples for Verification: For copings, roof-edge flashings, roof-edge drainage systems, and counterflashings made from 12-inch lengths of full-size components including fasteners, cover joints, accessories, and attachments.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for roof-edge flashings.

C. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

B. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

C. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof specialties installation.

1.9 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EXPOSED METALS

A. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

1. (All Areas, Unless Specified Below) Surface: Smooth, flat finish.

   a. Three-Coat Fluoropolymer: AAMA 620. System consisting of primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent PVDF resin by weight.

b. Concealed Surface: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2. (Areas around Waiting Area Flat Roof) Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:

1. Exposed High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. (All Areas, Unless Specified Below) Two-Coat Fluoropolymer: AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

2. (Areas around Waiting Area Flat Roof) Clear Anodic Finish, Coil Coated: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.2 CONCEALED METALS

A. Aluminum Sheet: ASTM B 209, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and structural performance indicated, mill finished.

2.3 UNDERLAYMENT MATERIALS

A. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.
2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
3. Products: Subject to compliance with requirements, provide one of the following:

a. Carlisle Coatings & Waterproofing; CCW WIP 300HT.
b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
c. Henry Company; Blueskin PE200 HT.
d. Metal-Fab Manufacturing, LLC; MetShield.
e. Owens Corning; WeatherLock Metal High Temperature Underlayment.

C. Polyethylene Sheet: 6-mil- thick polyethylene sheet complying with ASTM D 4397.

D. Slip Sheet: Building paper, 3-lb/100 sq. ft. minimum, rosin sized.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:

1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.

C. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

D. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 COPINGS

A. Copings: Manufactured coping system consisting of formed-metal coping cap in section lengths not exceeding 12 feet, concealed anchorage; corner units, end cap units, and concealed splice plates with same finish as coping caps.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Castle Metal Products.
   b. Hickman Company, W. P.
   c. Petersen Aluminum Corporation.

2. Coping-Cap Material: Formed or Extruded aluminum, thickness as required to meet performance requirements.

   a. (All areas, unless specified otherwise below) Finish: Two-coat fluoropolymer.
   b. Color: Custom Color to match color specified on Drawings.
   c. (Waiting Area Flat Roof) Finish: Clear anodic.

3. Corners: Factory mitered and soldered or continuously welded.
4. Special Fabrications: Stepped profile to match drawings..
5. Coping-Cap Attachment Method: Snap-on or Face leg hooked to continuous cleat with back leg fastener exposed, fabricated from coping-cap material.
6. Snap-on-Coping Anchor Plates: Concealed, galvanized-steel sheet, 12 inches wide, with integral cleats.

7. Face Leg Cleats: Concealed, continuous galvanized-steel sheet.

2.6 ROOF-EDGE FLASHINGS

A. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on or compression-clamped metal fascia cover in section lengths not exceeding 12 feet and a continuous formed galvanized-steel sheet cant, 0.028 inch thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Castle Metal Products.
   b. Hickman Company, W. P.
   c. Petersen Aluminum Corporation.

2. Fascia Cover: Fabricated from the following exposed metal:
   a. Extruded Aluminum: Thickness as required to meet performance requirements.

3. Corners: Factory mitered and soldered or continuously welded.
4. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
5. Special Fabrications: Sections as indicated on the Drawings
6. Fascia Accessories: Fascia extenders with continuous hold-down cleats.

2.7 ROOF-EDGE DRAINAGE SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Castle Metal Products.
   2. Hickman Company, W. P.
   3. Perimeter Systems; a division of Southern Aluminum Finishing Company, Inc.

B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Fabricate from the following exposed metal:
   a. Formed Aluminum: 0.050 inch thick.
2. Gutter Profile: As indicated on Drawings and according to SMACNA's "Architectural Sheet Metal Manual."
3. Applied Fascia Cover (Concealed Gutter): Exposed, formed aluminum, 0.040 inch thick, with factory-mitered corners, ends, and concealed splice joints. Corners: Factory mitered and soldered or continuously welded.
4. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters.
5. Special Fabrications: Shape as indicated on drawings.

6. Gutter Accessories: Continuous screened leaf guard with sheet metal frame or Continuous hinged leaf guard of solid metal designed to shed leaves, and Wire ball downspout strainer.

C. Downspouts: Plain rectangular complete with smooth-curve elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Extruded Aluminum: 0.125 inch thick.

2.8 COUNTERFLASHINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Castle Metal Products.
2. Fry Reglet Corporation.
3. Hickman Company, W. P.

B. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
1. Formed Aluminum: 0.032 inch thick.

C. Accessories:

1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

D. Aluminum Finish: Two-coat fluoropolymer and Clear anodic (Waiting Room Roof).

2.9 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

B. Self-Adhering Sheet Underlayment: Install wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water. Overlap edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

C. Polyethylene Sheet: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches.

D. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches.

3.3 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete roof-specialty systems.

1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
2. Provide uniform, neat seams with minimum exposure of solder and sealant.
3. Install roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
4. Torch cutting of roof specialties is not permitted.
5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum and stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of self-adhering, high-temperature sheet underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise shown on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Seal joints with elastomeric or butyl sealant as required by roofing-specialty manufacturer.

F. Seal joints as required for watertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

3.4 COPING INSTALLATION

A. Install cleats, anchor plates, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor copings to meet performance requirements.

1. Interlock face and back leg drip edges of snap-on coping cap into cleated anchor plates anchored to substrate at manufacturer's required spacing that meets performance requirements.
2. Interlock face leg drip edge into continuous cleat anchored to substrate at manufacturer's required spacing that meets performance requirements. Anchor back leg of coping with screw fasteners and elastomeric washers at manufacturer's required spacing that meets performance requirements.

3.5 ROOF-EDGE FLASHING INSTALLATION

A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.

B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.6 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 12 inches apart. Attach ends with rivets and solder to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion joint caps.
2. Install continuous leaf guards on gutters with noncorrosive fasteners, removable or hinged to swing open for cleaning gutters.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.

1. Provide elbows at base of downspout to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

D. Splash Pans: Install where downspouts discharge on low-slope roofs. Set in elastomeric sealant.

E. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.

1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
2. Loosely lock front edge of scupper with conductor head.
3. Seal or solder exterior wall scupper flanges into back of conductor head.

3.7 COUNTERFLASHING INSTALLATION

A. General: Coordinate installation of counterflashings with installation of base flashings.

B. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric or butyl sealant. Fit counterflashings tightly to base flashings.

3.8 CLEANING AND PROTECTION

A. Clean and neutralize flux materials. Clean off excess solder and sealants.

B. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

C. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077253 - SNOW GUARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:
1. Snow guards for metal roofs.
2. Non-penetrating attachment system.
3. Color-matched metal strips.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for snow guards.

C. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.
1. Include details of rail-type snow guards.
2. Include calculation of number and location of snow guards based on snow load, roof slope, roof type, components, spacings, and finish, tailored to match actual project conditions.

D. Samples: Clamps, cross member and snow and ice clips.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Test Reports: For each type of snow guard, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver twenty-five (25) spare snow and ice clips to Owner per the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Structural Performance:
   1. Snow Loads: As indicated on Structural Drawings.

2.2 RAIL-TYPE SNOW GUARDS

A. Seam-Mounted, Rail-Type Snow Guards:

B. Basis-of-Design Product: Subject to compliance with requirements, provide Colorguard bar #76, Colorguard versaclip #88, S-5 #96 tall snowclip 3, S-5 #S5T2K Clamps, by Alpine Snow Guards, Stowe, VT www.alpinesnowguards.com (888) 766-4273 (Basis of Design) or approved equal.

   1. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with one rail with color-matching inserts of material and finish used for metal roofing.

      a. Clamps: Manufactured from 6061-T6 aluminum extrusions conforming to ASTM B221 or aluminum castings conforming to ASTM B85 and to AA Aluminum Standards and Data.
      b. Set screws: 300 Series stainless steel, 18-8 alloy, 3/8 inch diameter, with round nose point.
      c. Attachment bolts: 300 Series stainless steel, 18-8 alloy, 10 mm diameter, with flat washers.
      d. Cross members: Manufactured from 6061-T6 alloy and temper aluminum extrusions conforming to ASTM B221 and AA Aluminum Standards and Data.

Receptacle in face to receive color-matched metal strips. Provide splice connectors ensuring alignment and structural continuity at end joints.

e. Color Strips: Same material and finish as roof panels; obtained from roof panel manufacturer.

f. Snow and Ice Clips: Aluminum, with rubber foot, minimum 3 inches wide.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates including compatibility with existing finishes or primers.
2. Prior to beginning installation, verify that:
   a. Panel seaming is complete.
   b. Panel attachment is sufficient to withstand loads applied by snow guard system.
   c. Installation will not impede roof drainage.
   d. Matching color strips have been procured by the roof panel manufacturer.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean areas to receive attachments; remove loose and foreign matter that could interfere with installation or performance.

3.3 INSTALLATION

A. Attachment for Standing-Seam Metal Roofing:

1. Install snow guards according to manufacturer's written instructions. Space as indicated on drawings.
2. Do not use fasteners that will penetrate metal roofing, or fastening methods that void metal roofing finish warranty.
3. Place clamps in straight, aligned rows.
4. Place both set screws on same side of clamp.
5. Tighten set screws to manufacturer's recommended torque. Randomly test set screw torque using calibrated torque wrench.
6. Insert color-matched metal strips into cross members, staggering strips to cover cross member joints.
7. Attach cross members to clamps; tighten bolts to manufacturer's recommended torque.
8. Install splice connectors at cross member end joints.
9. Do not cantilever cross members more than 3 inches beyond last clamp at ends.

END OF SECTION 077253

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

C. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. Qualification Data: For qualified Installer.

D. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
    b. Classification markings on penetration firestopping correspond to designations listed by the following:

        1) UL in its "Fire Resistance Directory."
        2) FM Global in its "Building Materials Approval Guide."

D. Preinstallation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Grace Construction Products.
   2. Hilti, Inc.
   3. Johns Manville.
   4. 3M Fire Protection Products.
   5. Tremco, Inc.; Tremco Fire Protection Systems Group.
   6. USG Corporation.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

   1. Fire-resistance-rated walls include fire-barrier walls.
   2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

   1. Horizontal assemblies include floors floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
   2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
   3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

    a. Slag-wool-fiber or rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.5 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. High performance, closed cell, preformed joint seals and adhesive/bonding agent at platform joints in accordance with the details shown on the plans and the requirements of the specifications.
2. Silicone joint sealants.
3. Urethane joint sealants.
4. Latex joint sealants.

B. Related Sections:

1. Section 084423 "Structural-Sealant-Glazed Curtain Walls" for structural and other glazing sealants.
2. Section 088000 "Glazing" for glazing sealants.
3. Section 092613 "Gypsum Veneer Plastering" for sealing perimeter joints and penetrations.
4. Section 092900 "Gypsum Board" for sealing perimeter joints.
5. Section 321373 "Concrete Paving Joint Sealants" for sealing joints in pavements, walkways, and curbing.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each joint-sealant product indicated.

C. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For qualified Installer.

C. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

D. Warranties: Sample of special warranties.

E. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

C. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 WARRANTY

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

C. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

D. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

D. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 PREFORMED JOINT MATERIALS

A. Preformed Foam Joint: Manufacturer's standard preformed joint produced from low density closed cell cross linked Ethylene Vinyl Acetate Polyethylene Copolymer nitrogen blown material utilizing hindered amine light stabilizer for U.V. stability exhibiting the physical properties listed in the table below:

PHYSICAL PROPERTIES	TEST METHOD	REQUIREMENT
Elongation at break	ASTM D3575; Suffix: T	225% avg.
Tensile Strength, psi (kPa)	ASTM D3575; Suffix: T	115 psi +/- 20%
Tear Resistance	ASTM D624	10 – 20 lbs/inch
Density	ASTM D3575; Suffix W, Method A	2.7 – 3.4 lbs/ft^3
Water Absorption	ASTM D3575; Suffix L	0.035 lbs/ft^2 avg.
Compression Deflection	ASTM D3575	25% 6 psi avg. 50% 16 psi avg.
Weather / Deterioration	ASTM G154	3000 hours No Effect
Compression Set 50% compression for 22 hours @ 73^o F (23^o C) 2 hr recovery 50% compression for 22 hours @ 73^o F (23^o C) 24 hour recovery	ASTM D3575; Suffix: B	 10% set 9% set
Extrusion (specimen compressed 60% of original thickness with 3 restrained sides)	ASTM D545	Extrusion on free side does not exceed 0.25 inches (6.4mm)
Operating Temperature	In House	160° F (71° C) max.
Movement Range Compression Tension Shear (Horizontal & Vertical)	In House	 50% 25% 50%±

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Ceva 100 System by E-Poxy Industries (Chase Corporation)

   b. Approved Equal

2.3 URETHANE JOINT SEALANTS

A. JS-1, JS-2, and JS-3 Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Bostik, Inc.; Chem-Calk 500.
   b. May National Associates, Inc.; Bondaflex PUR 2 NS.
   c. Pacific Polymers International, Inc.; Elasto-Thane 227 Type II.
   d. Pecora Corporation; Dynatred.
   e. Sika Corporation, Construction Products Division; Sikaflex - 2c EZ Mix.
   f. Tremco Incorporated; Vulkem 227.

2.4 SEALANT/ADHESIVE

A. JS-4 Joint Adhesive: 100% solids two component moisture insensitive modified epoxy adhesive which meets ASTM C-881 Type I & II Grades 1& 2 Class B & C and the requirements of the properties listed below:

Properties (uncured):

	Part A	**Part B**	**Mixed**
Color (Beige or Gray):	White/White	Carmel/Gray	Beige/Gray
Shelf Life	2 Years	2 Years	
Mixing ratio (By Vol)	3	1	3:1
Specifc Gravity	1.47	1.15	
Density (lbs/gal) @ 77 ^{o} F (25 ^{o} C)	12.0 +/-0.5	9.7 +/-0.2	11.6 +/-0.2
Viscosity (cps) @ 77 ^{o} F (25 ^{o} C)	35,000	33,000	26,000
Pot Life (200 gms)			32-36 minutes
Initial Set @ 77 ^{o} F			1 ½ - 2 Hours
Initial Cure			8-12 hours
Full Chemical Cure			7 days

Properties after Cure:

TEST	**TEST METHOD**	**REQUIREMENT**
Compressive Strength	ASTM D695	7000 psi
Tensile Strength	ASTM D638	3500 psi
Elongation at Break	ASTM D638	3-5%
Shore D hardness	ASTM D2250	85±5
Water Absorption	ASTM D570	0.25%
Bond Strength	ASTM C-882	430 psi min
Lap Shear		2000 psi min

2.5 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide the following:
   a. Pecora Corporation; 864.

b. Sika Corporation, Construction Products Division; SikaSil WS 290.
c. Tremco Incorporated; Spectrem 3.

B. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide the following provide one of the following:
a. Dow Corning Corporation; 786 Mildew Resistant.
b. GE Advanced Materials - Silicones; Sanitary SCS1700.
c. Tremco Incorporated; Tremsil 200 Sanitary.

2.6 URETHANE JOINT SEALANTS

A. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:
a. Pecora Corporation; Dynatrol I-XL.
b. Sika Corporation, Construction Products Division; Sikaflex - 1a.
c. Tremco Incorporated; Vulkem 116.

B. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide the following:
a. Pecora Corporation; Urexpan NR-201.
b. Sika Corporation. Construction Products Division; Sikaflex - 1CSL.
c. Tremco Incorporated; Vulkem 45.

C. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide the following:
a. Pecora Corporation; Dynatred.
b. Sika Corporation, Construction Products Division; Sikaflex - 2c EZ Mix.
c. Tremco Incorporated; Vulkem 227.

D. Immersible, Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Uses T and I.

1. Products: Subject to compliance with requirements, provide the following:

a. Sika Corporation, Construction Products Division; Sikaflex - 1CSL.
b. Tremco Incorporated; Vulkem 45.

2.7 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide the following:
   a. May National Associates, Inc.; Bondaflex Sil-A 700.
   b. Pecora Corporation; AC-20+.
   c. Tremco Incorporated; Tremflex 834.

2.8 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 MISCELLANEOUS MATERIALS

A. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

B. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and

approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Cast-in-Place Concrete.
    b. Precast Structural Concrete
    c. Brick Masonry.
    d. Cast Stone.
    e. Precast Architectural Concrete

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.

B. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

    1. Do not leave gaps between ends of sealant backings.
    2. Do not stretch, twist, puncture, or tear sealant backings.
    3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Installation of Preformed Foam Joints: Install each length of preformed joints immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends,

turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.6 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces JS-1.

1. Joint Locations:

a. Control and expansion joints in brick pavers.
b. Isolation and contraction joints in cast-in-place concrete slabs.
c. Joints in pedestrian plazas
d. Joints between plant-precast architectural concrete paving units.
e. Joints between different materials listed above.

2. Urethane Joint Sealant: Immersible, single component, pourable, traffic grade.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces JS-#2.

1. Joint Locations:

a. Construction joints in cast-in-place concrete.
b. Joints between plant-precast architectural concrete units.
c. Control and expansion joints in unit masonry.
d. Joints between metal panels.
e. Joints between different materials listed above.
f. Perimeter joints between materials listed above and frames of doors and windows.
g. Control and expansion joints in overhead surfaces.

2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50**.**
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces JS-3.

1. Joint Locations:

a. Isolation joints in cast-in-place concrete slabs.
b. Control and expansion joints in tile flooring.
c. Other joints as indicated.
2. Urethane Joint Sealant: Multicomponent, nonsag, traffic grade, Class 25.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces JS-4.

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Perimeter joints of exterior openings where indicated.
c. Tile control and expansion joints.
d. Vertical joints on exposed surfaces of concrete walls and partitions.
e. Joints on underside of plant-precast structural concrete beams and planks.
f. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
2. Joint Sealant: Latex.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

4. Joint Sealant: Single component, nonsag, mildew resistant, acid curing.
5. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the article entitled, “Safety and Protection of the Railroad Traffic and Property”, “requirements for Temporary Protection Shields…” and other Amtrak Specifications in the General Provisions.

1.2 SUMMARY

A. Section includes:

1. Stainless-steel, hollow-metal doors.
2. Stainless-steel, hollow-metal frames.
3. Fire-rated hollow-metal doors and frames (at Pedestrian Bridge).

B. Related Sections:

1. Section 088000 "Glazing".
2. Section 087100 "Door Hardware."

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required.

F. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product test reports.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Fire-Rated Door and Window Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C and NFPA 257.

1. Temperature-Rise Limit: Provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.

C. Smoke- and Draft-Control Door Assemblies: Provide assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

C. Shipping Spreaders: Deliver welded frames with two removable spreader bars across bottom of frames, tack welded or mechanically attached to jambs and mullions.

D. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.

1. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.9 COORDINATION

A. Coordinate installation of anchorages for stainless-steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 FIRE PROTECTION-RATED FRAMING

A. Basis-of-Design Product: Subject to compliance with requirements, provide SAFTfire GPX Framing as manufactured and distributed by SAFTI First Fire Rated Glazing Solutions, 325 Newhall Street, San Francisco, CA 94124-2693; www.safti.com; (888)653-3333 (Basis of Design) or approved equal.

B. Performance Requirements:
1. Fire Rating: 120 minutes.
2. Fire Resistive Wall Assembly Certifications: 120 minute fire resistive wall assemblies tested in accordance with ASTM E119, NFPA 251, UL 263, and ULC-S101.
3. Fire Resistive Door Assembly Certifications: 90 minute fire resistive door assemblies tested in accordance with ASTM E119, NFPA 251, UL 263 and ULC-S101.
4. Fire Protective Window Assembly Certifications: 45 minute fire protective window assemblies shall be tested in accordance with NFPA 80, NFPA 257, ASTM E163, ASTM E2010, UL 9 and CAN4-S106.
5. Testing Laboratory: Fire test shall be conducted by a nationally recognized independent testing laboratory.

C. Listings and Labels:
1. Fire rated framing system shall be under current follow-up service by a nationally recognized independent laboratory approved by OSHA and maintain a current listing or certification. Assemblies shall be labeled in accordance with limits of listings.

D. Fire rated glass and framing must be provided by a single-source, US manufacturer. Distributors of fire rated glass and framing are not to be considered as manufacturers.

2.2 STAINLESS-STEEL DOORS

A. Description: Stainless-steel doors, not less than 1-3/4 inches thick, of seamless, hollow-metal construction. Construct doors with smooth, flush surfaces without visible joints or seams on faces.

1. Face Sheets: Fabricate from 0.062-inch- thick, stainless-steel sheet.
2. Core Construction: Fabricate doors with core indicated.

a. Welded Steel-Stiffened Core: 0.030-inch- nominal thickness uncoated steel vertical stiffeners extending full-door height, spaced not more than 6 inches apart, spot welded to face sheets a maximum of 5 inches o.c. Fill spaces between stiffeners with mineral-fiber insulation.
b. Laminated Core: Honeycomb of resin-impregnated kraft paper with maximum 1-inch cells or foam-plastic insulation fastened to face sheets with waterproof adhesive.
c. Laminated Steel-Stiffened Core: 0.030-inch- nominal thickness uncoated steel vertical stiffeners extending full-door height, spaced not more than 6 inches apart, fastened to face sheets with waterproof adhesive. Fill spaces between stiffeners with mineral-fiber insulation.
d. Fire-Rated Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

3. Thermal-Rated Doors: Provide doors fabricated with thermal-resistance value (R-value) of not less than 2.1 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.

4. Vertical Edges for Single-Acting Doors: Beveled 1/8 inch in 2 inches.
5.
6. Top and Bottom Channels: Closed with continuous channels, 0.060-inch- nominal thickness uncoated steel.

a. Spot welded to both face sheets.
b. Securely fastened using adhesive.

7. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 866 with reinforcing plates from stainless steel.

B. Performance: Level A, ANSI A250.4.

C. Materials:

1. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 316.
2. Steel Sheet: ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, Commercial Steel (CS), Type B.

D. Stainless-Steel Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

a. Run grain of directional finishes with long dimension of each piece.
b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
c. Directional Satin Finish: No. 4.

2.3 STAINLESS-STEEL FRAMES

A. Description: Fabricate stainless-steel frames of construction indicated, with faces of corners mitered and contact edges closed tight.

1. Door Frames: Machine mitered and full welded.

    a. Weld frames according to HMMA 820.
2. Door Frames for Openings 48 Inches Wide or Less: Fabricate from 0.078-inch- thick, stainless-steel sheet.
3. Door Frames for Openings More Than 48 Inches Wide: Fabricate from 0.109-inch-thick, stainless-steel sheet.
4. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 866 with reinforcing plates from stainless steel.
5. Jamb Anchors:
    a. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.050-inch- thick stainless steel.
    b. Compression Type for Slip-on Frames: Fabricate adjustable compression anchors from stainless steel.

6. Floor Anchors: Not less than 0.078-inch- thick stainless steel, and as follows:

    a. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

B. Performance: Level A, ANSI A250.4.

C. Materials:

1. Stainless-Steel Sheet: ASTM A 240/A 240M, austenitic stainless steel, Type 316.
2. Frame Anchors: Stainless-steel sheet. Same type as door face.
3. Inserts, Bolts, and Anchor Fasteners: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 for bolts and nuts.

D. Finishes:

1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

    a. Run grain of directional finishes with long dimension of each piece.
    b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
    c. Directional Satin Finish: No. 4.

2.4 FABRICATION

A. Stainless-Steel Door Fabrication: Stainless-steel doors to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal.

1. Seamless Edge Construction: Door face sheets joined at vertical edges by continuous weld extending full height of door; with edges ground and polished, providing smooth, flush surfaces with no visible seams.
2. Exterior Doors: Close top edges flush and seal joints against water penetration. Provide weep-hole openings in bottom of exterior doors to permit moisture to escape.
3. Stops and Moldings: Factory cut openings in doors. Provide stops and moldings around glazed lites. Form corners of stops and moldings with butted or mitered hairline joints.

    a. Glazed Lites: Provide fixed stops and moldings welded on secure side of door.
    b. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

4. Hardware Preparation: Factory prepare stainless-steel doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Section 087100 "Door Hardware."

    a. Reinforce doors to receive nontemplated mortised and surface-mounted door hardware.

5. Locate hardware as indicated, or if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."
6. Tolerances: Fabricate doors to tolerances indicated in ANSI/NAAMM-HMMA 866.

B. Stainless-Steel Frame Fabrication: Fabricate stainless-steel frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

1. Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated from same thickness metal as frames.

2. Provide countersunk, flat-, or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
4. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

        1) Two anchors per jamb up to 60 inches in height.
        2) Three anchors per jamb from 60 to 90 inches in height.
        3) Four anchors per jamb from 90 to 96 inches in height.
        4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.

b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches in height.
2) Four anchors per jamb from 60 to 90 inches in height.
3) Five anchors per jamb from 90 to 96 inches in height.
4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.
5) Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.

c. Compression Type: Not less than two anchors in each jamb.
d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

5. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

6. Hardware Preparation: Factory prepare stainless-steel frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Section 087100 "Door Hardware."

a. Reinforce frames to receive nontemplated mortised and surface-mounted door hardware.
b. Locate hardware as indicated, or if not indicated, according to HMMA 831, "Recommended Hardware Locations for Custom Hollow Metal Doors and Frames."

7. Tolerances: Fabricate frames to tolerances indicated in ANSI/NAAMM-HMMA 866.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation and with installation spreaders in place, adjust and securely brace stainless-steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.2 INSTALLATION

A. General: Install stainless-steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with ANSI/NAAMM-HMMA 866 and manufacturer's written instructions.

B. Stainless-Steel Frames: Install stainless-steel frames of size and profile indicated.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    d. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.
3. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
4. Installation Tolerances: Adjust stainless-steel frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Stainless-Steel Doors: Fit doors accurately in frames with the following clearances:

1. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

3.3 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the article entitled, "SAFTEY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the content.

1.2 SUMMARY

A. Section Includes:

1. Access doors and frames for walls and ceilings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Access Panel Solutions.
2. Acudor Products, Inc.
3. Alfab, Inc.
4. Babcock-Davis.
5. Cendrex Inc.
6. Elmdor/Stoneman Manufacturing Co.; Div. of Acorn Engineering Co.
7. Jensen Industries; Div. of Broan-Nutone, LLC.

8. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
9. Karp Associates, Inc.
10. Larsen's Manufacturing Company.
11. Maxam Metal Products Limited.
12. Metropolitan Door Industries Corp.
13. MIFAB, Inc.
14. Milcor Inc.
15. Nystrom, Inc.
16. Williams Bros. Corporation of America (The).

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Flush Access Doors with Exposed Flanges:

1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
2. Locations: Wall and ceiling.
3. Door Size: 12” x 16” (WALL) and 12” x 12” (CEILING)
4. Material and Finish (Ceilings and Walls): Stainless Steel, nominal 0.060 inch, 16 gage.
5. Frame Material: Same material, thickness, and finish as door.
6. Hinges: Manufacturer's standard.
7. Hardware: Lock.

D. Hardware:

1. Latch: Cam latch operated by hex-head wrench.
2. Lock: Cylinder.

a. Lock Preparation: Prepare door panel to accept cylinder specified in Section 087100 "Door Hardware."

2.2 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

C. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

E. Frame Anchors: Same type as door face.

F. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

G. Stainless Steel: Type 304 or 316.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder locks, furnish two keys per lock and key all locks alike.
2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

2.4 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Steel and Metallic-Coated-Steel Finishes:

1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

E. Stainless Steel Finish: #4 directional finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113

SECTION 083113.53 - SECURITY ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the article entitled, "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes security access doors and frames for precast concrete ramp walls.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail fabrication and installation of access doors and frames for each type of substrate.

D. Samples: For each door face material.

E. Schedule: Types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 tested according to the following test method:

1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.

2.2 SECURITY ACCESS DOORS AND FRAMES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Acudor Products, Inc.
2. Babcock-Davis.
3. Cendrex Inc.
4. J. L. Industries, Inc.; Div. of Activar Construction Products Group.
5. Karp Associates, Inc.
6. Larsen's Manufacturing Company.
7. Metropolitan Door Industries Corp.
8. MIFAB, Inc.
9. Nystrom, Inc.

B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Maximum-Security Flush Access Doors :

1. Basis-of-Design Product: Indicated on Drawings.
2. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
3. Locations: Precast concrete ramp walls.
4. Door Size: 24”x24”.

5. Metallic-Coated Steel Sheet for Door: Nominal 0.183 inch , 7 gage.

    a. Finish: Factory prime.

6. Frame: Minimum 3/16-by-2-by-2-by-3-inch angle welded with joints ground smooth.
7. Hinges: Heavy-duty steel welded to door and frame.
8. Hardware: Tamper-resistant lock.

D. Hardware:
1. Lock: Mortise cylinder.
2. Lock Preparation: Prepare door panel to accept cylinder specified in Section 087100 "Door Hardware."

2.3 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.

D. Frame Anchors: Same type as door face.

E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.

D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.

1. For cylinder lock, furnish two keys per lock and key all locks alike.

2.5 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Steel and Metallic-Coated-Steel Finishes:

1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
2. Factory Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry-film thickness of 1 mil for topcoat.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113.53

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Exterior storefront framing.
   a. 6" System – Stair and Elevator Towers.
   b. 4 ½" System – Pedestrian Walkway Bridge

B. Related Sections:

1. Section 074243, "Composite Wall Panels".
2. Section 088000, "Glazing".

C. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.

2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:

    a. Joinery, including concealed welds.
    b. Anchorage.
    c. Expansion provisions.
    d. Glazing.
    e. Flashing and drainage.

3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:

1. Joinery, including concealed welds.
2. Anchorage.
3. Expansion provisions.
4. Glazing.
5. Flashing and drainage.

G. Delegated-Design Submittal: For aluminum-framed storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

B. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

C. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C 1401 recommendations for post-installation-phase quality-control program.

D. Warranty: Submit warranty documents specified herein.

E. Project Record Documents: Submit project record documents for installed materials in accordance with Division 1.

1.5 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

C. Laboratory Mockup Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

D. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

E. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.

F. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

G. Structural-Sealant Glazing: Comply with ASTM C 1401 for design and installation of storefront systems.

1.6 MOCKUPS

A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical wall area as shown on Drawings.
2. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration created by wind and thermal and structural movements.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Water penetration through fixed glazing and framing areas.
e. Failure of operating components.

2. Warranty Period: Five years from date of Substantial Completion.

C. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Owner will engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.

B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Aluminum-framed storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
2. Failure also includes the following:

    a. Thermal stresses transferring to building structure.
    b. Glass breakage.
    c. Noise or vibration created by wind and thermal and structural movements.
    d. Loosening or weakening of fasteners, attachments, and other components.
    e. Failure of operating units.

C. Structural Loads:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings**.**

D. Deflection of Framing Members: At design wind pressure, as follows:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding 1/175 of the glass edge length for each individual glazing lite**.** or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.

    a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.

3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:

    a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.

E. Structural: Test according to ASTM E 330 as follows:

1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:

1. Fixed Framing and Glass Area:

    a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..

G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..

H. Water Penetration under Dynamic Pressure: Test according to AAMA 501.1 as follows:

1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.

I. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

1. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement.
2. Vertical Interstory Movement: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.7 at design displacement and 1.5 times the design displacement.

J. Energy Performance: Certify and label energy performance according to NFRC as follows:

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.45 Btu/sq. ft. x h x deg F. as determined according to NFRC 100.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 as determined according to NFRC 200.
3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 15 as determined according to NFRC 500.

K. Noise Reduction: Test according to ASTM E 90, with ratings determined by ASTM E 1332, as follows.

1. Outdoor-Indoor Transmission Class: Minimum 26.

2. Large-Missile Test: For glazed openings located within 30 feet of grade.

L. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

    a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
    b. Low Exterior Ambient-Air Temperature: 0 deg F.
    c. Interior Ambient-Air Temperature: 75 deg F

2.2 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide YKK AP YES 45 TU Front Set 6" and 4 ½" Storefront Framing System as manufactured by YKK AP America Inc. or comparable product by one of the following:
   1. EFCO Corporation.
   2. Kawneer North America.
   3. Oldcastle BuildingEnvelope.

B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

2.3 FRAMING

A. Framing Members: Manufacturer's extruded or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.

   1. Construction: Extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads. >.
   2. Glazing System: Retained mechanically with gaskets on four sides.
   3. Glazing Plane: Front set, exterior glazed. - Stair and Elevator Towers.
   4. Glazing Plane: Front set, interior glazed - Pedestrian Walkway Bridge.
   5. Finish: Clear anodic finish. Final selection by Architect.
   6. Fabrication Method: Field-fabricated stick system.

B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.

C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Materials:

   1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

      a. Sheet and Plate: ASTM B 209.
      b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
      c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
      d. Structural Profiles: ASTM B 308/B 308M.

   2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.

      a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
      b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
      c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 INSULATED SPANDREL PANELS

A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.

1. Overall Panel Thickness: 1 inch
2. Exterior Skin: Aluminum.

    a. Thickness: Manufacturer's standard for finish and texture indicated. .125
    b. Finish: Custom Kynar finish of color to match sample provided by Architect.
    c. Texture: Smooth.
    d. Backing Sheet: thick, cement board.

3. Interior Skin: Aluminum.

    a. Thickness: Manufacturer's standard for finish and texture indicated
    b. Finish: Mill finish] .
    c. Texture: Smooth.
    d. Backing Sheet: thick, cement board.

4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board**.**

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25or less.
2. Smoke-Developed Index: 50or less.

C.

2.5 GLAZING

A. Glazing: Comply with Section 088000 "Glazing."

B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

C. Glazing Sealants: Comply with Section 088000 "Glazing.".

D. Structural Glazing Sealants: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in storefront system indicated.

1. Color: As selected by Architect from manufacturer's full range of colors

E. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.

1. Color: Match structural sealant.

2.6 ACCESSORIES

A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.

1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.

C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

2.7 Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.
3. Physical and thermal isolation of glazing from framing members.
4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
5. Provisions for field replacement of glazing from exteriorand exterior for spandrel metal panels.
6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. Storefront Framing: Fabricate components for assembly using shear-block system.

G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES Retain finishes in paragraphs below to suit Project. If retaining more than one, indicate location of each on Drawings or by inserts. Aluminum-framing systems are available with dual finishes, allowing different interior and exterior color finishes. See "Aluminum Finishes" Article in the Evaluations for additional information.

1.

B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent FEVE resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Provide at all storefront framing.

1. Color and Gloss: Match Architect's sample

2.9 SOURCE QUALITY CONTROL

A. Structural Sealant: Perform quality-control procedures complying with ASTM C 1401 recommendations including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.

3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install glazing as specified in Section 088000 "Glazing."

F. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.4 ERECTION TOLERANCES

A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
3. Alignment:

    a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engagea qualified testing agency to perform tests and inspections.

B. Field Quality-Control Testing: Perform the following test on representative areas of aluminum-framed entrances and storefronts

1. Water-Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

a. Perform a minimum of three tests in areas as directed by Architect.

C. Structural-Sealant Adhesion: Test structural sealant according to recommendations in ASTM C 1401, Destructive Test Method A, "Hand Pull Tab (Destructive)," Appendix X2.

1. Test a minimum of fourareas on each building facade.
2. Repair installation areas damaged by testing.

D. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 084113

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the article entitled, "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY "and other Amtrak Specifications in the Contract.

1.2 SUMMARY

A. Section includes:

1. Furnishing and installation of all mechanical and electrical finish hardware necessary for all doors, and hardware as specified herein and as enumerated in hardware sets and as indicated and required by actual conditions at the building. The hardware shall include the furnishing of all necessary screws, bolts, expansion shields, drop plates, and all other devices necessary for the proper application of the hardware.

B. Related Sections:

1. Section 081119 – Stainless Steel Doors and Frames
2. Section 083113 – Access Doors and Frames
3. Section 083113.53 – Security Access Doors and Frames
4. Section 088000 - Glazing
5. Division 26 - Electrical
6. Division 28 – Electronic Safety and Security

1.3 REFERENCES

A. Applicable state and local building codes and standards.

B. FIRE/LIFE SAFETY

1. NFPA - National Fire Protection Association

a. NFPA 70 – National Electric Code
b. NFPA 80 - Standard for Fire Doors and Fire Windows
c. NFPA 101 - Life Safety Code
d. NFPA 105 - Smoke and Draft Control Door Assemblies

C. UL - Underwriters Laboratories

1. UL 10C - Positive Pressure Test of Fire Door Assemblies
2. UL 1784 - Air Leakage Tests of Door Assemblies
3. UL 305 - Panic Hardware

D. Accessibility

1. ADA - Americans with Disabilities Act
2. ICC / ANSI A117.1 - Accessible and Usable Buildings and Facilities

E. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware

F. ANSI - American National Standards Institute

1. ANSI/BHMA A156.1 - A156.29, and ANSI A156.31 - Standards for Hardware and Specialties

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

C. Shop Drawings: Details of electrified door hardware, indicating the following:

1. Wiring Diagrams: For power, signal, and control wiring and including the following:

a. Details of interface of electrified door hardware and building safety and security systems.
b. Schematic diagram of systems that interface with electrified door hardware.
c. Point-to-point wiring.
d. Risers.

2. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

D. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

a. Submittal Sequence: Submit door hardware schedule after submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware

schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

b. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.

c. Format: Use same scheduling sequence and format as in the Contract Documents.

d. Content: Include the following information:

1) Identification number, location, hand, fire rating, size, and material of each door and frame.
2) Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
3) Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
4) Description of electrified door hardware sequences of operation and interfaces with other building control systems.
5) Fastenings and other pertinent information.
6) Explanation of abbreviations, symbols, and codes contained in schedule.
7) Mounting locations for door hardware.
8) List of related door devices specified in other Sections for each door and frame.

2. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

3. Samples: If requested by the Architect, submit production sample or sample installations as requested of each type of exposed hardware unit in the finish indicated, and tagged with a full description for coordination with the schedule.

a. Samples will be returned to the supplier in like-new condition. Units that are acceptable to the Architect may, after final check of operations, be incorporated into the Work, within limitations of key coordination requirements.

4. Templates: After final approval of the hardware schedule, provide templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware.

5. Elevation and Wiring Diagrams: After final approval of the hardware schedule, submit elevation and wiring diagrams as required for the proper installation of complete electrical, electromechanical, and electromagnetic products.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer and Architectural Hardware Consultant.

C. Product Certificates: For electrified door hardware, from the manufacturer.

1. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

D. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

E. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.

C. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as follows:

1. For door hardware, an Architectural Hardware Consultant (AHC) who is also an Electrified Hardware Consultant (EHC).

D. Source Limitations: Obtain each type of door hardware from a single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

E. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

F. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.

G. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

H. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

I. Accessibility Requirements: For door hardware on doors in an accessible route, comply with ICC/ANSI A117.1 and the Connecticut State Building Code.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:
   a. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

C. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

D. Deliver keys to Owner by registered mail or overnight package service.

1.8 COORDINATION

A. Prior to ordering hardware, coordinate keying with Mr. David A. Hartley of the Connecticut Department of Transportation.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

E. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.9 WARRANTY

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of doors and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

a. Electromagnetic Locks: Five years from date of Substantial Completion.
b. Exit Devices: Three years from date of Substantial Completion.
c. Locksets: 7 years, except electrified locksets.
d. Manual Closers: 10 years from date of Substantial Completion.
e. Butt Hinges and Continuous Hinges: Lifetime warranty.

1.10 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products equivalent in function and comparable in quality to named products.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.

2.2 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. IVES Hardware; an Ingersoll-Rand company.
   b. McKinney Products Company; an ASSA ABLOY Group company.
   c. Stanley Commercial Hardware; Div. of The Stanley Works.

2.3 SELF-CLOSING HINGES AND PIVOTS

A. Self-Closing Hinges and Pivots: BHMA A156.17.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Baldwin Hardware Corporation.
   b. McKinney Products Company; an ASSA ABLOY Group company.
   c. Stanley Commercial Hardware; Div. of The Stanley Works.

2.4 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.
2. Mortise Locks: Minimum 3/4-inch latchbolt throw.
3. Deadbolts: Minimum 1.25-inch bolt throw.

C. Lock Backset: 2-3/4 inches, unless otherwise indicated.

D. Lock Trim:

1. Description: As indicated in schedule.
2. Levers: Cast.
3. Escutcheons (Roses): Cast.
4. Operating Device: Lever with escutcheons (roses).

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

F. Bored Locks: BHMA A156.2; Grade 1; Series 4000.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Best Access Systems; Div. of Stanley Security Solutions, Inc.
   b. Corbin Russwin Architectural Hardware; n ASSA ABLOY Group Company.
   c. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
   d. Schlage Commercial Lock Division; an Ingersoll-Rand company.

2.5 ELECTRIC STRIKES

A. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Adams Rite Manufacturing Co.; an ASSA ABLOY Group company.
   b. Folger Adam Electric Door Controls; an ASSA ABLOY Group company.
   c. Von Duprin; an Ingersoll-Rand company.

2.6 SURFACE BOLTS

A. Surface Bolts: BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Burns Manufacturing Incorporated.
   b. Door Controls International, Inc.
   c. IVES Hardware; an Ingersoll-Rand company.
   d. Trimco.

2.7 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Adams Rite Manufacturing Co.; an ASSA ABLOY Group company.
   b. IVES Hardware; an Ingersoll-Rand company.
   c. Trimco.

2.8 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

A. Automatic and Self-Latching Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Door Controls International, Inc.
    b. IVES Hardware; an Ingersoll-Rand Company.
    c. Trimco.
    d. Rockwood Manufacturing Company

2.9 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Adams Rite Manufacturing Co.; an ASSA ABLOY Group company.
    b. Arrow USA; an ASSA ABLOY Group company.
    c. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
    d. Precision Hardware, Inc.; Division of Stanley Security Solutions, Inc.
    e. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
    f. Von Duprin; an Ingersoll-Rand company.

2.10 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

1. Manufacturer: Same manufacturer as for locking devices.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. ASSA, Inc.; An ASSA ABLOY Group Company.
    b. Best Access Systems; Div. of Stanley Security Solutions, Inc.
    c. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
    d. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
    e. Schlage Commercial Lock Division; an Ingersoll-Rand company.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1; permanent cores that are interchangeable; face finished to match lockset.

C. High-Security Lock Cylinders: BHMA A156.30; Grade 1; Type ; permanent cores that are removable; face finished to match lockset.

D. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

E. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.11 KEYING

A. Temporary 7 pin cores shall be furnished by the contractor for all locks. Cores to be 626 Finish in the Best / Falcon “A” keyway. Cores to be keyed 1335331 for an operating key and operated by a control key of 4118114.

B. One control key and one operating key shall be forwarded to Mr. David A. Hartley and 10 operating keys are to be forwarded to the Engineer.

C. Permanent cores will be furnished, keyed, and installed by the State upon completion of the Project. The State will retain the temporary cores.

2.12 OPERATING TRIM

A. Operating Trim: BHMA A156.6; stainless steel, unless otherwise indicated.

2.13 CLOSER HOLDER RELEASE DEVICES

A. Closer Holder Release Devices: BHMA A156.15; Grade 1; closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door shall become self-closing on interruption of signal to release device. Automatic release is activated by smoke detection system.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

      a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
      b. LCN Closers; an Ingersoll-Rand company.
      c. SARGENT Manufacturing Company; an ASSA ABLOY Group company.

2.14 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16; polished cast brass, bronze, or aluminum base metal.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:
      a. IVES Hardware; an Ingersoll-Rand company.
      b. Rockwood Manufacturing Company.
      c. Stanley Commercial Hardware; Div. of The Stanley Works.

2.15 ELECTROMAGNETIC STOPS AND HOLDERS

A. Electromagnetic Door Holders: BHMA A156.15, Grade 1; wall-mounted electromagnetic single unit with strike plate attached to swinging door; coordinated with fire detectors and interface with fire alarm system for labeled fire-rated door assemblies.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

a. Architectural Builders Hardware Mfg., Inc.
b. DORMA Architectural Hardware; Member of The DORMA Group North America.
c. SARGENT Manufacturing Company; an ASSA ABLOY Group company.

2.16 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: BHMA A156.8.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Architectural Builders Hardware Mfg., Inc.
b. Rockwood Manufacturing Company.
c. SARGENT Manufacturing Company; an ASSA ABLOY Group company.

2.17 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hager Companies.
b. M-D Building Products, Inc.
c. National Guard Products.
d. Pemko Manufacturing Co.; an ASSA ABLOY Group company.
e. Reese Enterprises, Inc.
f. Sealeze; a unit of Jason Incorporated.
g. Zero International.

2.18 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hager Companies.
b. M-D Building Products, Inc.
c. National Guard Products.
d. Pemko Manufacturing Co.; an ASSA ABLOY Group company.
e. Reese Enterprises, Inc.

f. Rixson Specialty Door Controls; an ASSA ABLOY Group company.
g. Sealeze; a unit of Jason Incorporated.
h. Zero International.

2.19 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- (1.3-mm-) thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Baldwin Hardware Corporation.
b. IVES Hardware; an Ingersoll-Rand company.
c. Rockwood Manufacturing Company.
d. Trimco.

2.20 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Rockwood Manufacturing Company.
b. Stanley Commercial Hardware; Div. of The Stanley Works.
c. Trimco.

2.21 AUXILIARY ELECTRIFIED DOOR HARDWARE

A. Auxiliary Electrified Door Hardware:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. GE Security, Inc.
b. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
c. Schlage Commercial Lock Division; an Ingersoll-Rand company.
d. Security Door Controls.

2.22 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and

hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Fire-Rated Applications:

    a. Wood or Machine Screws: For the following:

        1) Hinges mortised to doors or frames.
        2) Strike plates to frames.
        3) Closers to doors and frames.

    b. Steel Through Bolts: For the following unless door blocking is provided:

        1) Surface hinges to doors.
        2) Closers to doors and frames.
        3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."
5. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.23 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches (750 mm) of door height greater than 90 inches (2286 mm).

E. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.

F. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.

1. Configuration: Provide one power supply for each door opening with electrified door hardware.

G. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

H. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.3 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.4 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.5 DOOR HARDWARE SCHEDULE

A. Provide hardware for each door to comply with requirements of Section “Finish Hardware,” hardware set numbers indicated in door schedule, and in the following schedule of hardware sets.

B. Locksets, exit devices, and other hardware items are referenced in the Hardware Sets for series, type, and function. Refer to the preamble for special features, options, cylinders/keying, and other requirements.

C. Hardware Sets:

Hardware Set # 1

3 ea	Hinge	CB199 4.5” (5” @ 4’ wide drs) x 4.5” x US26D NRP	Stanley
1 ea	Storeroom Lock	93K-7D 14C 626	Best
1 ea	Closer	D-4550 HCS 689	Stanley
1 ea	Kick Plate	K1050 10” x 2” less dr width 4BD CSK 630	Rockwood
1 st	Seals	706A x head & jambs	NGP
1 ea	Sweep	C627 x door width	NGP
1 ea	Threshold	896V x opening width	NGP

Hardware Set # 2

6 ea	Hinge	CB199 4.5” x 4.5” x US26D NRP	Stanley
2 ea	Flush Bolts	555 x 570 strike 630	Rockwood
1 ea	Storeroom Lockset	93L-7D 14C 626	Best
2 ea	Closer	D-4550 HCS 689	Stanley
2 ea	Kick Plate	K1050 10” x 2” less dr width 4BD CSK 630	Rockwood
1 st	Seals	706A x head and jambs	NGP
2 ea	Sweep	C627 x door width	NGP
1 st	Astragal	115N x door height	NGP
1 ea	Threshold	896V x opening width	NGP

Hardware Set # 3

3 ea	Hinge	CB179 4.5” x 4.5” US26D NRP	Stanley
1 ea	Storeroom Lock	93K-7D 14C 626	Best
1 ea	Closer	D-4551 S 689	Stanley
1 ea	Kick Plate	K1050 10” x 2” less dr width 4BD CSK 630	Rockwood
3 ea	Silencer	608	Rockwood

Hardware Set # 4

6 ea	Hinge	CB168 4.5” X 4.5” US26D NRP	Stanley
2 ea	Flush Bolt	555 x 570 Strike 630	Rockwood
1 ea	Storeroom Lock	93K-7D 14C 626	Best
1 ea	Closer	D-4551 S 689	Stanley
2 ea	Kick Plate	K1050 10” x 2” less dr width 4BD CSK 630	Rockwood
1 ea	Overhead Stop	19000 push side	Rockwood
2 ea	Silencer	608	Rockwood

Hardware Set # 5

6 ea	Hinge	CB168 4.5” X 4.5” US26D NRP	Stanley
2 ea	Exit Devices	2114 x 4914 LD LBR 630	Precision
1 ea	Closer	D-4551 S 689	Stanley
2 ea	Magnetic Holder	2100 Series ABH	
2 ea	Kick Plate	K1050 10” x 2” less dr width 4BD CSK 630	Rockwood
2 ea	Silencer	608	Rockwood

Hardware Set # 6 – gates

1 ea	Alamed Exit Device	2114 ALK exit only 626 battery operated	Precision
1 ea	Cylinder	Mortise type as required for ALK kit	Best

Remainder of hardware by gate manufacturer. Drill two weep holes in bottom of exit device center case for precipitation escape.

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
1. Glazing in elevator towers, stair towers, pedestrian overpass and platform shelters.

B. Related Sections:
1. Section 084113 , “Aluminum Framed Entrances And Storefronts”

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Design glass, including comprehensive engineering analysis according to ICC's 2003 International Building Code (except as amended, altered or deleted by the 2005 Connecticut State Building Code with 2009 Amendments) by a qualified professional engineer, using the following design criteria:

1. Design Wind Pressures: As indicated on Drawings.
2. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
3. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
4. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing will not be required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
2. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.6 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each glass product and glazing material indicated.

C. Glass Samples: For each type of the following products; 12 inches square.

1. Tinted glass.
2. Frosted glass
3. Laminated glass.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For installers.

C. Product Certificates: For glass and glazing products, from manufacturer.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for glazing sealants and glazing gaskets.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

E. Preconstruction adhesion and compatibility test report.

F. Warranties: Sample of special warranties.

G. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

E. Source Limitations for Glass: Obtain laminated glass and insulating glass from single source from single manufacturer for each glass type.

F. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

G. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark each glass with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies. Label shall not be obscured by frame assembly.

H. Fire-Protection-Rated Glazing Labeling: Permanently mark each fire-protection-rated glass panel with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes. Label shall not be obscured by frame assembly.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

C. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F.

1.11 WARRANTY

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass

contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: 10 years from date of Substantial Completion.

D. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes enhanced-protection testing requirements in ASTM E 1996 for Wind Zone 1 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.
1. Large-Missile Test: For all glazing, regardless of height above grade.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.

B. Ultraclear Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I, complying with other requirements specified and with visible light transmission not less than 91 percent and solar heat gain coefficient not less than 0.87.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. AFG Industries, Inc.; Krystal Klear.
b. Guardian Industries Corp.; Ultrawhite.
c. Pilkington North America; Optiwhite.
d. PPG Industries, Inc.; Starphire.

C. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
2. For uncoated glass, comply with requirements for Condition A.
3. For coated vision glass, comply with requirements for Condition C (other coated glass).

D. Silicone-Coated Spandrel Glass: ASTM C 1048, Condition C, Type I, Quality-Q3, and complying with other requirements specified.

1. Glass: Tinted float.
2. Tint Color: As selected by Architect from manufacturer’s full range.
3. Silicone Coating Color: As selected by Architect from manufacturer's full range.

2.3 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after

fabrication and installation. Provide safety glazing labeling. Markings as specified in ANSI Z97.1, shall be present on each separate piece of glass and shall remain visible after installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written recommendations.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

B. Windborne-Debris-Impact-Resistant Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, with "Windborne-Debris-Impact Resistance" Paragraph in "Glass Products, General" Article, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation. Provide safety glazing labeling. Markings as specified in ANSI Z97.1, shall be present on each separate piece of glass and shall remain visible after installation.

1. Construction: Laminate glass with one of the following to comply with interlayer manufacturer's written recommendations:

    a. Polyvinyl butyral interlayer.
    b. Polyvinyl butyral interlayers reinforced with polyethylene terephthalate film.
    c. Ionoplast interlayer.
    d. Cast-in-place and cured-transparent-resin interlayer.
    e. Cast-in-place and cured-transparent-resin interlayer reinforced with polyethylene terephthalate film.

2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

C. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.

2.4 FIRE-PROTECTION-RATED GLAZING

A. Basis-of-Design Product: Subject to compliance with requirements, provide SuperLite II-XL 120 minute fire resistive glazing with hose stream as manufactured and distributed by SAFTI First, 325 Newhall Street, San Francisco, CA 94124-2693; (888)653-3333 (Basis of Design) or approved equal.

1. Design Requirements:
    a. Make-up: Must be comprised of inboard and outboard tempered lites protecting a fire resistive interlayer.
    b. Thickness: 1-1/2” standard profile.
    c. Weight: 12 lbs./sq. ft. in 1-1/2” standard profile.
    d. NFRC Certifications in conjunction with GPX Framing by SAFTI First.
        1) Must meet NFRC 100 rated U-Factor of 0.34 when insulated with Solarban 60.

2) Must meet NFRC 200 rated SHGC of 0.27 when insulated with Solarban 60.
3) Must meet NFRC 500 rated Condensation Resistance of 55 when insulated with Solarban 60.

e. Sound Transmission Rating: Must provide a minimum of STC 44 Rating in 1-1/2" (39 mm) standard profile.
f. Appearance: Must be tint-free, optically clear fire rated glazing.
g. Fire Rating: Must be fire rated to 120 minutes with hose stream and meet ASTM E-119.
h. Impact Safety Resistance: CPSC 16 CFR 1201 Cat. I & II.

2.5 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:

1. Neoprene complying with ASTM C 864.
2. EPDM complying with ASTM C 864.
3. Silicone complying with ASTM C 1115.
4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene EPDM silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.

1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

C. Lock-Strip Gaskets: Neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock-strips, complying with ASTM C 542, black.

2.6 GLAZING SEALANTS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Dow Corning Corporation; 790.
    b. Pecora Corporation; 890.
    c. Sika Corporation, Construction Products Division; SikaSil-C990.
    d. Tremco Incorporated; Spectrem 1.

C. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    a. Dow Corning Corporation; 995.
    b. Pecora Corporation; 898.
    c. Sika Corporation, Construction Products Division; SikaSil-C995.
    d. Tremco Incorporated; Spectrem 3.

D. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.7 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.9 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

2.10 LAMINATED-GLASS TYPES

A. Glass Type : Clear laminated glass with two plies of ultraclear fully tempered float glass.

1. Thickness of Each Glass Ply: As indicated.
2. Interlayer Thickness: 0.030 inch.
3. Provide safety glazing labeling. Markings as specified in ANSI Z97.1, shall be present on each separate piece of glass and shall remain visible after installation.

2.11 FIRE-PROTECTION-RATED GLAZING TYPES

A. Glass Type : 120-minute fire-rated glazing with 450 deg F temperature rise limitation; laminated glass with intumescent interlayers or gel-filled, double glazing units.

1. Provide safety glazing labeling.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 LOCK-STRIP GASKET GLAZING

A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

3.8 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 089000 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:

1. Fixed, storm class extruded-aluminum louvers.

B. Related Sections:

1. Section 042113 – Brick Masonry
2. Section 047200 – Cast Stone Masonry
3. Section 074213.19 – Insulated Metal Wall Panels
4. Section 07243 – Composite Wall Panels
5. Section 079200 – Joint Sealants
6. Section 081119 - Stainless Steel Doors and Frames
7. Section 233100 – Sheet Metal Work and Accessories

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

D. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
   1. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft. (1436 Pa) acting inward or outward.

1.5 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

   1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

C. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

   1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
   2. Show mullion profiles and locations.
   3. Wiring Diagrams: For power, signal, and control wiring for motorized adjustable louvers.

D. Samples for Verification: For each type of metal finish required.

1.6 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.9 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.

D. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
2. For color-finished louvers, use fasteners with heads that match color of louvers.

2.2 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches o.c., whichever is less.

F. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Storm-Resistant Louver:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Airolite Company, LLC (The); Model SCH201 (Basis of design).
   b. Arrow United Industries; a division of Mestek, Inc.
   c. Greenheck Fan Corporation.

2. Louver Depth: 6 inches.
3. Blades shall be horizontal, inverted-V type with a center hook and spaced approximately 1”on center.
4. Frame and Blade Nominal Thickness: Not less than 0.063 inch min.
5. Louver Performance Ratings:
   a. Free Area: Not less than 39%.
   b. Wind-Driven Rain Performance: Not less than 99.5 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 189 fpm.
6. Decorative Cross Bracing: Provide extruded aluminum cross bracing (as shown on drawings) affixed to exterior of louver with concealed fasteners.

2.4 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.5 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. High-Performance Organic Finish: 3-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: Match custom color indicated on drawings.

2.6 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.

2. Screening Type: Bird screening.

B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches (150 mm) from each corner and at 12 inches (300 mm) o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same kind and form of metal as indicated for louver to which screens are attached.
2. Finish: Same finish as louver frames to which louver screens are attached.
3. Type: Non-rewirable, U-shaped frames.

D. Insulated, Blank-Off Panels: Laminated panels consisting of an insulating core surfaced on back and front with metal sheets and attached to back of louver.

1. Thickness: 2 inches.
2. Metal Facing Sheets: Aluminum sheet, not less than 0.032-inch (0.81-mm) nominal thickness.
3. Insulating Core: Insert insulation material.
4. Edge Treatment: Trim perimeter edges of blank-off panels with louver manufacturer's standard channel frames, with corners mitered and with same finish as panels.
5. Seal perimeter joints between panel faces and louver frames with gaskets or sealant.
6. Panel Finish: Same type of finish applied to louvers, but black color.
7. Attach blank-off panels with sheet metal screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089000

SECTION 092116.23 - GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816-2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitle “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in this Contract.

1.2 SUMMARY

A. Section Includes: Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each component of gypsum board shaft wall assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Evaluation Reports: For shaft wall assemblies, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: Provide materials and construction identical to those of assemblies tested according to ASTM E 90 and classified according to ASTM E 413 by a testing and inspecting agency.

C. Low-Emitting Materials: Gypsum shaft wall assemblies shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

A. Fire-Resistance Rating: 2 hours.

B. STC Rating: 51, minimum.

C. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.

1. Depth: 4 inches.
2. Minimum Base-Metal Thickness: 0.033 inch.

D. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.

1. Minimum Base-Metal Thickness: Matching steel studs.

E. Firestop Tracks: Provide firestop track at head of shaft wall on each floor level.

F. Room-Side Finish: As indicated.

G. Shaft-Side Finish: Gypsum shaftliner board, moisture- and mold-resistant Type X.

H. Insulation: Sound attenuation blankets.

2.3 PANEL PRODUCTS

A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Gypsum Shaftliner Board, Moisture- and Mold-Resistant Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with moisture- and mold-resistant core and surfaces.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed Corp.; ProRoc Moisture and Mold Resistant Shaftliner.
    b. Georgia-Pacific Gypsum LLC, Subsidiary of Georgia Pacific; Dens-Glass Ultra Shaftliner.
    c. National Gypsum Company; Gold Bond Brand Fire-Shield Shaftliner XP.
    d. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panel.

2. Thickness: 1 inch.
3. Long Edges: Double bevel.
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

C. Gypsum Board: As specified in Section 092900 "Gypsum Board."

D. Cementitious Backer Units: As specified in Section 093013 "Ceramic Tiling."

2.4 NON-LOAD-BEARING STEEL FRAMING

A. Recycled Content of Steel: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Steel Framing Members: Comply with ASTM C 645 requirements for metal unless otherwise indicated.

1. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized unless otherwise indicated.

C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
    b. Grace Construction Products; FlameSafe FlowTrak System.
    c. Metal-Lite, Inc.; The System.

d. Steel Network Inc. The VertiTrack VTD Series.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.

B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.

C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.

D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.

1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.
2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 conducted by a qualified testing agency.

E. Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, elevator hoistway door frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.

B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.

C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.

1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
2. Reinforcing: Where handrails directly attach to gypsum board shaft wall assemblies, provide galvanized steel reinforcing strip with 0.033-inch minimum thickness of base metal (uncoated), accurately positioned and secured behind at least one layer of face panel.

D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.

F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

G. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.

H. Cant Panels: At projections into shaft exceeding 4 inches, install 5/8-inch- thick gypsum board cants covering tops of projections.

1. Slope cant panels at least 75 degrees from horizontal. Set base edge of panels in adhesive and secure top edges to shaft walls at 24 inches o.c. with screws fastened to shaft wall framing.
2. Where steel framing is required to support gypsum board cants, install framing at 24 inches o.c. and extend studs from the projection to shaft wall framing.

I. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 PROTECTION

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, or mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092116.23

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings and soffits.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior non-load-bearing wall studs; roof rafters and misc. framing.

1.2 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: Provide materials and construction identical to those tested according to ASTM E 119.

B. STC-Rated Assemblies: Provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413.

2.2 FRAMING SYSTEMS

A. Steel Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.

1. Minimum Base-Metal Thickness: 0.027 inch].
2. Depth: 3-5/8 inches].

B. Slip-Type Head Joints: Where indicated, provide one of the following in thickness not less than indicated for studs and in width to accommodate depth of studs:

1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- deep flanges, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
        2) MBA Building Supplies; Slotted Deflecto Track.
        3) Steel Network Inc. (The); VertiTrack VTD Series.
        4) Superior Metal Trim; Superior Flex Track System (SFT).
        5) Telling Industries; Vertical Slip Track II.

C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness:] 0.027 inch.

D. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: 0.033 inch.
2. Depth: As indicated on Drawings.

F. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

1. Configuration: hat shaped.

G. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.

1. Depth: As indicated on Drawings.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch.
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

C. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.

1. Depth: 2-1/2 inches.

E. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs and Runners: ASTM C 645.[**Use either steel studs and runners or dimpled steel studs and runners of equivalent minimum base-metal thickness.**]
   a. Minimum Base-Metal Thickness: 0.027 inchDepth: As indicated on Drawings.

3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

   a. Minimum Base-Metal Thickness: 0.033 inch.

4. Resilient Furring Channels: 1/2-inch- deep members designed to reduce sound transmission.

   a. Configuration: hat shaped.

2.4 AUXILIARY MATERIALS

A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provideasphalt saturated organic felt.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.
1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.2 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:

    a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
    b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Z-Furring Members:

1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

    a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
5. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:
   1. Gypsum board and accessories.

B. Related Requirements:

   1. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
   2. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
   3. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
   4. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. USG Corporation.

B. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M, Level 1.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

C. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

A. Trim: ASTM C 1047.

1. Material: Hot-dip galvanized steel sheet, plastic, or rolled zinc.
2. Shapes:

a. Cornerbead.
b. LC-Bead: J-shaped; exposed long flange receives joint compound.
c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Gypsum Board: Paper.

C. Joint Compound for Exterior Applications:

1. Gypsum Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Wallboard Type: As indicated on Drawings.
2. Abuse-Resistant Type: As indicated on Drawings.
3. Moisture- and Mold-Resistant Type: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with

vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. Bullnose Bead: Use at outside corners.
3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use where indicated.
5. U-Bead: Use where indicated.
6. Curved-Edge Cornerbead: Use at curved openings.

3.5 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 5: All locations.

a. Primer and its application to surfaces are specified in other Section 099123 "Interior Painting."

3.6 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816-2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:
   1. Porcelain tile.
   2. Tile backing panels.

B. Related Requirements:
   1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."

C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

   1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Initial Selection: For tile, grout, and accessories involving color selection.

E. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Full-size units of each type of trim and accessoryfor each color and finish required.

1.6 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer.

C. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

D. Product Certificates: For each type of product.

E. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications:

1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
3. Installer employs Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Build mockup of each type of wall tile installation.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

C. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

D. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

E. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.

1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
1. Cementitious backer units.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

2.3 TILE PRODUCTS

A. Ceramic Tile Type CT-1: Factory-mounted ceramic porcelain tile.
1. Basis-of-Design Product: Subject to compliance with requirements, provide StonePeak Ceramics, Inc. (312) 506-2800, Materia 3D, or approved equal.
2. Composition: Porcelain.
3. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
4. Module Size: 12”x24”x1/3”.
5. Thickness: 1/3 inch.
6. Face: Plain.
7. Surface: Smooth, without abrasive admixture.
8. Finish: Honed.
9. Tile Color and Pattern: Materia 3D - Platinum - Running bond with 33% offset maximum.
10. Grout Color: As selected by Architect from manufacturer's full range.

    a. External Corners for Portland Cement Mortar Installations: Bead (bullnose), module size 24 inch by 2 inch.
    b. Internal Corners: Field-butted square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

B. Ceramic Tile Type CT-2: Factory-mounted ceramic porcelain tile.

1. Basis-of-Design Product: Subject to compliance with requirements, provide StonePeak Ceramics, Inc. (312) 506-2800, Materia 3D, or approved equal.
2. Composition: Porcelain.
3. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
4. Module Size: 12”x24”x1/3”.
5. Thickness: 1/3 inch.
6. Face: Plain.
7. Surface: Smooth, without abrasive admixture.
8. Finish: Honed.
9. Tile Color and Pattern: Materia 3D – Heather Grey - Running bond with 33% offset maximum.
10. Grout Color: As selected by Architect from manufacturer's full range.

C. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, Type A, in maximum lengths available to minimize end-to-end butt joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. C-Cure; C-Cure Board 990.
b. Custom Building Products; Wonderboard.
c. FinPan, Inc.; ProTEC Concrete Backer Board.
d. USG Corporation; DUROCK Cement Board.

2.4 Thickness: 5/8 inch SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thinset) – Specifically designed for large format tile: ANSI A118.4.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Laticrete International, Inc.; 4-XLT, or comparable product by one of the following:

a. MAPEI Corporation; Ultraflex LFT.
b. Merkrete Systems; Parex USA, Inc.; 855 XXL.

2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with acrylic resin liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
5. Provide modified thinset specifically designed for tiles over 15" that can be applied thicker for adjustability for lippage and accommodates heavier large tiles applied to walls without sagging.

2.5 GROUT MATERIALS

A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Laticrete International, Inc. or approved equal.

2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.

2.6 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for wall applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Blanke Corporation.
b. Ceramic Tool Company, Inc.
c. Schluter Systems L.P.

C. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

2.7 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other

substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.

2. Verify that concrete substrates for tile walls installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

    a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile walls installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
    a. Tile walls consisting of tiles 12 inches by 24 inches or larger.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in running-bond pattern with 33% maximum offset unless otherwise indicated. Lay out tile work and center tile fields in both directions on each wall area, unless otherwise indicated. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
1. Porcelain Tile: 1/8 inch.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

3.4

3.5 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.6 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls.

B. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.7 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

A. Interior Wall Installations, Wood or Metal Studs or Furring:

END OF SECTION 093013

SECTION 093050 -TACTILE WARNING STRIP - SURFACE APPLIED

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies furnishing and installing surface applied composite tactile tiles for passenger platforms as indicated on plans, using an exterior grade tactile warning surface tile herein.

B. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

C. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

D. This designation is the "*Basis of Design*" to which a Contractor's submittal must meet or exceed in terms of quality, finish, operation and appearance (see 2.1B).

1.2 RELATED SECTIONS

Division 03, Section 035300, "Concrete Topping".

1.3 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR - SUBMITTALS.

B. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.

C. Samples for Verification Purposes: Submit three (3) samples of full size surface applied composite tactile tiles of the kind proposed for use.

D. Shop drawings are required for products specified showing fabrication details; tile surface profile; fastener type and locations; plans of tile placement including joints, installation procedure and material to be used as well as outlining installation materials and procedure.

E. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties indicated.

F. Maintenance Instructions: Submit copies of manufacturer's specified maintenance practices for each type of tactile tile and accessory as required. For more information refer to NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Provide surface applied tactile tiles and accessories as produced by a single manufacturer.

C. Installer's Qualifications: Engage an experienced Installer certified in writing by tactile flooring manufacturer as qualified for installation, who has successfully completed tile installations similar in material, design, and extent to that indicated for Project. Manufacturer's supervisor shall be present at all times.

1.5 REGULATORY REQUIREMENTS

Comply with provisions of the following:

A. Americans with Disabilities Act: Provide tactile warning surfaces which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, Part 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES. In addition products must comply with CALIFORNIA TITLE 24 requirements regarding patterns, color and sound on cane contact.

B. Comply with all local, municipal, state and federal agencies and their regulations having jurisdiction over the project.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings, and tile type shall be identified by part number.

C. Tiles shall be delivered to a secured location specified by the Contractor for storage prior to installation.

1.7 SITE CONDITIONS

A. Environmental Conditions and Protection: Maintain minimum temperature of 40 degrees F in spaces to receive tactile tiles for at least 48 hours prior to installations, during installation, and for not less than 48 hours after installation. Store tactile tiles material in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 40 degrees F in areas where work is completed.

B. The use of water for work, cleaning or dust control, etc. shall be in contained and controlled and shall not be allowed to come into contact with the passengers or public. Provide barricades or screens to protect passengers or public.

C. Disposal of any liquids or other materials of possible contamination shall be made in accordance with federal state and local laws and ordinances.

D. Cleaning materials shall have code acceptable low VOC solvent content and low flammability if used on the site.

E. Contractor shall coordinate phasing and flagging personnel operations as specified elsewhere.

1.8 EXTRA STOCK

A. Deliver extra stock to warehouse designated by Designer. Furnish new materials from same manufactured lot as materials installed and enclose in protective packaging with appropriate identification. Furnish not less than two 2% of the supplied materials for each type, color and pattern installed. For more information refer to NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.9 GUARANTEE

A. Surface applied composite tactile tiles shall be guaranteed in writing for a period of five (5) years from date of final completion. The guarantee includes defective work, breakage, deformation, fading and chalking of finishes, and loosening of panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: The Vitrified Polymer Composite (VPC) Surface Applied Tactile Tiles specified and shown on the plans is based on “Armor-Tile” manufactured by *Engineered Plastics, Inc*. (800-682-2525). Existing engineered ADA and California

Title 24 field tested products in service for a minimum of 2 years which are subject to compliance with requirements, may be incorporated in the work and shall meet or exceed the specified test criteria and characteristics.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Engineered Plastics, Inc., “Armor-Tile”
2. ADA Solutions

2.2 VITRIFIED POLYMER COMPOSITE (VPC) TACTILE TILES

A. Vitrified Polymer Composite (VPC) Surface Applied Tactile Tiles: An epoxy polymer composition with an ultra-violet coating employing aluminum oxide particles in the truncated domes and the following:

1. Tile Dimensions: Nominal 2 ft. by 4 ft. by 0.125 inches thick; 0.325 inches thick at the domes, with a 1/2" inch deep front edge flange and 1/2 inch deep back flange. Tiles shall be formed with holes for anchors in the dome; minimum of 14 holes per tile. Three of the holes shall be in the first row of domes which overlaps and fastens through a 1 inch lap-flange in the next tile.

2. Water Absorption of Tile when tested by ASTM-D 570 not to exceed 0.35%.

3. Slip Resistance of Tile when tested by ASTM-C 1028 the combined wet/dry static co-efficient of friction not to be less than 0.80.

4. Compressive Strength of tile when tested by ASTM-D 695-91 not to be less than 18,000 psi.

5. Tensile Strength of Tile when tested by ASTM-D 638-91 not to be less than 10,000 psi.

6. Flexural Strength of Tile when tested by ASTM - C293-94 not to be less than 24,000 psi.

7. Gardner Impact to geometry "GE" of the standard when tested by ASTM-D 5420-93 to have a mean failure energy expressed as a function of specimen thickness of not less than 450 in. lbf/in. A failure is noted if a hairline fracture is visible in the specimen.

8. Chemical Stain Resistance of Tile when tested by ASTM-D 543-87 to withstand without discoloration or staining - 1% hydrochloric acid, urine, calcium chloride, stamp pad ink, gum and red aerosol paint.

9. Abrasive Wear of Tile when tested by BYK - Gardner Tester ASTM-D 2386 with reciprocating linear motion of 37+/- cycles per minute over a 10" travel. The abrasive medium, a 40 grit Norton Metallite sand paper, was fixed and leveled to a holder. The combined mass of the sled, weight and wood block is 3.2 lb. Average wear depth shall not exceed 0.030 after 1000 abrasion cycles measured on the top surface of the dome representing the average of three measurement locations per sample.

10. Fire Resistance: When tested to ASTM E84 flame spread shall be less than 25.

11. Accelerated Weathering of Tile when tested by ASTM-G26-95 for 2000 hours shall exhibit the following result - no deterioration, fading or chalking of surface of tile.

12. Accelerated Aging and Freeze Thaw Test of Tile and Adhesive System when tested to ASTM-D 1037 shall show no evidence of cracking, delamination, warpage, checking, blistering, color change, loosening of tiles or other defects.

13. Salt and Spray Performance of Tile and Adhesive System when tested to ASTM-B 117 not to show any deterioration or other defects after 100 hours of exposure.

14. Color: Yellow conforming to Federal Color No. 33538. Color shall be homogenous throughout the tile.

2.3 MISCELLANEOUS MATERIALS

A. Stainless steel low profile expansion anchors 1/4 inch diameter by 1-1/8 inch long to be positioned in the molded recess of fourteen truncated domes per tile minimum.

B. Heavy-duty elastomeric polyurethane adhesive

1. Available Manufactures:
   a. Boiardi
   b. Mapei
   c. Bostik
   d. Approved equal.

C. Fasteners: Provide Type 304 or 316 stainless-steel fasteners for exterior use. Select fasteners for type, grade, and class required

PART 3 - EXECUTION

3.1 INSTALLATION

A. During all surface preparation and tile installation procedures ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.

B. The application of all adhesives, sealants and mechanical fasteners shall be in strict accordance with the guidelines set by their respective manufacturers.

C. Throughout the installation phases of surface preparation and tile setting, ensure that care is taken to prevent damage to any work.

D. Work with the Contractor to ensure that the surfaces being prepared and fabricated to receive the tiles is constructed correctly and adequately for the tile installation. Review the plans with the Contractor prior to construction and refer any and all discrepancies to the Engineer and Designer.

E. Ensure all dimensions and tolerances are as shown on the contract drawing. Use two of the tactile tiles shipped as a template to check all tolerances are within that of the contract drawing.

F. The surface is to be vacuumed and flushed with clean clear water, free from all dirt and debris. Visually inspect all surface for obtrusions or foreign matter. If obtrusions are present, promptly grind away, making sure edges are not chipped or damaged.

G. Immediately prior to installing the surface applied tactile tiles, all surfaces must be inspected to ensure that they are clean, dry, free of voids, curing compounds, projections, loose material, dust, oils, grease, sealers and determined to be structurally sound before the application of the setting adhesive. The setting adhesive requires that the substrate and the ambient temperature are 40 degree F minimum.

H. On planed (milled) concrete surfaces:

1. Spread the adhesive to provide complete coverage over the planed concrete surface and platform edge, using a clean, well-maintained 1/4" x 1/4" V notch trowel. The adhesive is also to be applied to the leading edge to a depth of 1/2" for proper tile embedment.

2. Inspect the tile and clean with acetone all dust and other contaminants from the surfaces to be adhered, then set the tile in place, true and square to the platform edge. Drill holes true and straight to the depth required using the recommended bit with holes located by the molded recesses provided in the tile. Clean dust from the holes to provide clear passage for the anchor.

3. Mechanically fasten tiles to the floor surface using a punch pin and hammer to set the stainless steel impact anchors provided. Ensure the fastener has been set

to full depth, straight and true. Care should be taken when setting the fastener to avoid any inadvertent blows with the hammer to the tile surface. **Fasteners (and drilled holes) shall be installed to a depth not greater than one (1) inch below the top plane of the adjacent concrete topping.**

4. Following the installation of the tiles and allowing the tile setting adhesive 12 hours for curing, the urethane sealant system color matched to the adjacent floor finish should be applied to the leading edge to finish the tile flush with the adjacent floor finish. Follow the manufacturer's recommendations when mixing or applying the sealant system and ensure that the joint is clean and free of debris, and any excess adhesive is cut away to provide sufficient depth for the sealant in the saw cut in accordance with the plans.

I. On the aluminum fold-up edge: Mechanically fasten tiles to aluminum surface using stainless steel set screws in each of the pre-drilled dome holes, as required by the Manufacturer.

J. The leading edge of the tile should be checked to ensure that the tolerance provided is in accordance with the plans. Adjustment to the tiles leading edge is accomplished with a small shim driven into the leading edge saw cut to wedge the tile flange against the side walls of the groove and hold the tile to the desired elevation.

K. All subsequent tiles are set following the same procedures as outlined above. The gap of 1/8" allowed between tiles for expansion and contraction is mandatory.

L. After the platform edge has been fully tiled and sealant system applied, the tile surface shall be cleaned, following the recommended maintenance and cleaning procedures.

3.2 CLEANING AND PROTECTING

A. Protect panels against damage during construction period to comply with tactile panel manufacturer's specification.

B. Protect panels against damage from rolling loads following installation by covering with plywood or hardwood.

C. Clean tactile panels not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean tactile panel by method specified by tactile panel manufacturer.

END OF SECTION 093050

SECTION 095133 - ACOUSTICAL METAL PAN CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical metal pans and associated suspension system for interior ceilings.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):

a. ASTM A 641 “Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire”
b. ASTM C 423 “Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method”
c. ASTM E 84 “Standard Test Method for Surface Burning Characteristics of Building Materials”
d. ASTM E 1264 Classification for Acoustical Ceiling Products
e. ASTM E1477 “Standard Test for Luminous Reflectance Factor of Acoustical Materials by use of Integrating-Sphere Reflectometers”

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Samples: For each exposed product and for each color and texture specified.

D. Delegated-Design Submittal: For design of seismic restraints and attachment devices.

1.4 INFORMATIONAL SUBMITTALS

A. Product test reports.

B. Evaluation reports.

1.5 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR-CLOSEOUT DOCUMENTS

B. Maintenance data.

1.6 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Testing Agency Qualifications: Qualified according to NVLAP.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical ceiling area as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic restraints and attachment devices.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL METAL PAN CEILINGS, GENERAL

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent for metal pan ceilings and not less than 25 percent for sound-absorbent insulation.

B. Glass-Fiber Insulation: Made with binder containing no urea formaldehyde.

C. Acoustical Panel Standard: Comply with ASTM E 1264.

D. Metal Suspension System Standard: Comply with ASTM C 635/C 635M.

E. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

F. Sheet Metal Characteristics: For metal components exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, roughness, stains, or discolorations.

1. Aluminum Sheet: Rolled aluminum sheet, complying with ASTM B 209; alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

G. Sound-Absorbent Pads: Provide width and length to completely fill concealed surface of pan, with surface-burning characteristics for flame-spread index of 25 or less and smoke-developed index of 50 or less, as determined by testing according to ASTM E 84, and to comply with the following requirements:

1. Plastic Sheet-Wrapped, Mineral-Fiber Insulation: Pads consisting of nonrigid, PVC plastic sheet encapsulating unfaced mineral-fiber insulation complying with ASTM C 553, Type I, Type II, or Type III, and as follows:

a. Mineral-Fiber Type and Thickness: Glass fiber; 3 inches.
b. Mineral-Fiber Density: 1-1/2 lb/cu. ft..
c. Plastic Sheet Thickness and Color: Not less than 0.003 inch; flat black.

2.3 ALUMINUM PANS FOR ACOUSTICAL METAL PAN CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong World Industries, Inc.; MetalWorks Metal Ceilings, or approved equal.

B. Classification: Units complying with ASTM E 1264 for Type VII, perforated aluminum facing (pan) with mineral- or glass-fiber-base backing.

1. Pattern: Microperforated.

C. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.

1. Clip-in Pans: Designed to clip in and be securely retained in exposed suspension grid by formed edges or accessory clips provided by manufacturer.
2. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.
3. Torsion-Spring-Hinged Pans: Designed to be securely retained in preslotted, exposed suspension grid by torsion springs provided by manufacturer.

D. Pan Thickness: Not less than 0.040 inch.

E. Pan Edge Detail: Reveal.

F. Pan Size: 16 inches x 72 inches.

G. Pan Face Finish: Painted in color selected from manufacturer's full range.

H. Light Reflectance LR: Not less than ASTM E 1477; White Panel: Microperforated 0.61

2.4 METAL SUSPENSION SYSTEM FOR ACOUSTICAL SNAP-IN METAL PAN CEILING

A. Manufacturers: Subject to compliance with requirements, provide products by snap-in metal pan ceiling manufacturer.

B. Indirect-Hung, Snap-Tee System: Designed to support metal pans that snap into main runners, consisting of main runners connected to carrying channels that are attached by hangers to building structure.

C. Access Panels: For access at locations indicated, provide acoustical snap-in metal pan ceiling units.

1. Access Key or Tool: Provide manufacturer's standard key or tool for opening access panels; four.

D. Exposed Metal Edge Moldings and Trim: Provide exposed members as indicated or as required to comply with seismic requirements of authorities having jurisdiction, to conceal edges of and penetrations through ceiling, to conceal edges of pans and runners, for fixture trim and adapters, for fasciae at changes in ceiling height, and for other conditions; of metal and finish matching acoustical metal pan ceiling units unless otherwise indicated.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 ALUMINUM FINISHES

A. Mill Finish: AA-M10C10 (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned).

B. Lacquered Mill Finish: AA-M10C10R1x (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned; Organic Coating: as specified below).

1. Organic Coating: Manufacturer's standard clear organic coating.

C. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

D. Color-Coated Finish: Manufacturer's standard powder-coat baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install acoustical metal pan ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.

C. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim. Comply with installation tolerances according to CISCA's "Metal Ceilings Technical Guidelines."

1. Install directionally patterned or textured metal pans in directions indicated.

D. Install sound attenuation panels in areas indicated by reflected ceiling plans or room finish schedules.

END OF SECTION 095133

SECTION 099113 - EXTERIOR PAINTING

PART 1 -

PART 2 - GENERAL

2.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

2.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following exterior substrates:
   1. Gypsum board.
   2. Incidental wood surfaces as indicated on the drawings or as directed by the Engineer.

B. All painted steel components shall be shop-applied, and are specified elsewhere.

C. Related Requirements:

   1. Section 051200 "Structural Steel Framing" for shop priming of metal substrates with primers specified in this Section.
   2. Section 099600 "High-Performance Coatings" for special-use coatings.
   3. Section 099300 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on exterior wood substrates.

2.3 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

E. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

2.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product. Include preparation requirements and application instructions.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
3. VOC content.

2.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Refer to NOTICE TO CONTRACTOR – CLOSING DOCUMENTS for more information.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

2.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

2.7 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

2.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 3 - PRODUCTS

3.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Benjamin Moore & Co.
2. ICI Paints.
3. Sherwin-Williams Company (The).

3.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.

D. Colors: As indicated in a color schedule.

3.3 PRIMERS/SEALERS

A. Primer, Alkali Resistant, Water Based: MPI #3.

B. Primer, Bonding, Solvent Based: MPI #69.

C. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.

3.4 WOOD PRIMERS

A. Primer, Alkyd for Exterior Wood: MPI #5.

B. Primer, Oil for Exterior Wood: MPI #7.

3.5 WATER-BASED PAINTS

A. 100% Acylic Latex, Exterior Semi-Gloss (Gloss Level 5): MPI #11.

3.6 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner may engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 4 - EXECUTION

4.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Wood: 15 percent.
2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

4.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

4.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

4.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

4.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

4.6 EXTERIOR PAINTING SCHEDULE

A. Wood Substrates:

1. Latex System with oil-based primer:

a. Sealer Coat: Water-repellant preservative
b. Prime Coat: Primer, Oil-based primer, MPI#7.
c. Intermediate Coat: Latex, 100% Acrylic semi gloss.
d. Topcoat: Latex, 100% Acrylic semi gloss.

B. Gypsum Board Substrates:

1. Latex System with Alkyd Primer:
   a. Prime Coat: Primer, Oil-based primer, MPI#7.

b. Primer, Alkyd for Exterior Wood: MPI #5 (over manufacturer's shop-applied primer)
c. Intermediate Coat: Latex, 100% Acrylic semi gloss.
d. Topcoat: Latex, 100% Acrylic semi gloss.

END OF SECTION 099113

SECTION 099300 - STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes surface preparation and application of wood finishes on the following substrates:

1. Exterior Substrates:
   a. Exposed dimension lumber (rough carpentry).
   b. Dressed lumber (finish carpentry).
   c. Wood soffit boards.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

C. Samples for Verification: For each type of finish system and in each color and gloss of finish indicated.

1. Submit Samples on representative samples of actual wood substrates, 8 inches square.
2. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:

1. Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. VOC content.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Mockups: Apply mockups of each finish system indicated and each color selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Designer will select one surface to represent surfaces and conditions for application of each type of finish system and substrate.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..

2. Final approval of stain color selections will be based on mockups.

a. If preliminary stain color selections are not approved, apply additional mockups of additional stain colors selected by Designer at no added cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply finishes when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

C. Do not apply exterior finishes in snow, rain, fog, or mist.

D. Stain applications will require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the article entitled, “Safety and Protection of the Railroad Traffic and Property”, “requirements for Temporary Protection Shields…” and other Amtrak Specifications in the General Provisions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Benjamin Moore & Co.
   2. ICI Paints.
   3. Samuel Cabot, Inc (Cabot)
   4. Sherwin-Williams Company (The).

2.2 MATERIALS, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

   1. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.

C. Stain Colors: Clear

2.3 BRIGHTENERS AND NEUTRALIZERS

A. Wood brightener and neutralizer for removing mill glaze and removing tannin and rust stains, Clear:

   1. Benjamin Moore BRIGHTEN Brightener and Neutralizer (317), or approved equal.

2.4 BASE COAT STAINS

A. Stain, Exterior, Waterborne alkyd/acrylic transparent

   1. Benjamin Moore Arborcoat Transparent Decking and Siding Stain (637), or approved equal.

2.5 PROTECTIVE CLEAR COAT

A. Stain, Exterior, 100% Acrylic Finish Coat
   1. Benjamin Moore Arborcoat Exterior Waterborne Stain Protective Clear Coat (636), or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with finish application only after unsatisfactory conditions have been corrected.

1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. To the greatest extent possible, apply prep and base coatings to lumber prior to installation of wood components, coating all sides of surfaces.

C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

D. Exterior Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Coat edges, ends, faces, undersides, and backsides of wood.
   a. For varnish coated stained wood, stain edges and ends and prime with varnish. Prime undersides and backsides with varnish.

3.3 APPLICATION

A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for finish and substrate indicated.

2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 EXTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. All exterior wood substrates.

1. Transparent Stain System:
   a. Wood Prep: Benjamin Moore BRIGHTEN Brightener and Neutralizer (317), or approved equal.
   b. Basecoat: Benjamin Moore Arborcoat Transparent Decking and Siding Stain (637), or approved equal.
   c. Topcoat: Benjamin Moore Arborcoat Exterior Waterborne Stain Protective Clear Coat (636), or approved equal.

END OF SECTION 099300

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes surface preparation, shop application and field touch up of high-performance coating systems on the following substrates:

1. Exterior Substrates:
   a. Steel.
   b. Thermal spray metalized steel

B. The adverse conditions dictated by work along a operating railroad necessitate the following conditions:

1. All high performance coatings will be shop-applied.
2. Areas that require field touch-up will be limited to connections and minor abrasions due to erection. Field touch-up is to be applied by the Painting Contractor, certified by the Manufacturer.

C. Related Sections:

1. Section 050310 "Thermal Spray Metalized Steel".

1.3 DEFINITIONS

A. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

B. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

C. Samples for Verification: For each type of coating system and in each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
3. VOC content.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply field touch-up of coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F.

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Carboline Company (Carboline).
2. DuPont Company, High Performance Coatings (DuPont).
3. International Protective Coatings; Courtaulds Coatings (International).
4. Tnemec Company, Inc. (Tnemec).

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
3. Provide products of same manufacturer for each coat in a coating system.

C. Colors: Custom color as indicated in the finish schedule on the drawings.
1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

2.3 SCHEDULE OF FINISHES

A. The Steel Fabricator shall finish structural steel components for high-performance coatings as specified below:

1. Exterior Exposed Structural Steel including the following components and systems are to receive a 3-coat finishing system per Section 09960 – High Performance Coatings.

a. Platform, canopy, stair/elevator towers: All steel members including columns, beams, purlins, roof framing components and accessories including base plates. Refer to Specification Section 05120 – Structural Steel for additional details.

b. Exterior platform railings and incorporated systems, stairs, gates, sign frames, brackets and fasteners, unless specified as galvanized and to remain unfinished and exposed to view (stair gratings). Refer to Specifications Section 055213 – Pipe and Tube Railings, 05500 - Metal Fabrications, and 05511 - Metal Stairs, for additional details.

c. Exposed tube steel framing and connected miscellaneous steel, including guard-rails/railing systems etc..

2. Structural Steel Systems including the following components and systems are to receive an epoxy-based ferrous metal paint system per Section 099113 – Exterior Painting. These systems are to receive a primer as defined in 099113.

a. Structural framing members supporting the precast platform planks.

3. The following items are hot-dipped galvanized:

a. Traffic surfaces such as metal stair grates and platforms.
b. Steel platform stair stringers and support structures.
c. Surfaces embedded in concrete or mortar.
d. Any remaining exterior exposed to weather steel as depicted in the contract drawings.

2.4 EXTERIOR HIGH-PERFORMANCE COATING SYSTEMS

A. Basis of Design: System specified is based upon a 3-coat priming and finishing system as manufactured by Tnemec, as follows:
1. Severe Environment (High-Gloss Finish): One finish coat over one intermediate coat and a primer.

a. Primer: Tnemec Series 90-97 Zinc @ 2.0-3.5 mils dry. Coordinate with steel fabricator for application, and Section 05120 – Structral Steel for priming and steel preprataion.
b. 2nd Coat: Tnemec Series 27 Typoxy (color) @ 3.0-5.0 mils dry.
c. 3rd Coat: Tnemec Series 73 Endura Shield (color) @ 1.5-3.0 mils dry.

2. Acceptable Systems:

a. Primer: Epoxy primer applied at spreading rate recommended by manufacturer.

1) Carboline: 893 2-Component Cross-Linked Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) International: Intergard 251 Thin- Film Polyamide Epoxy Rust Inhibitive Primer.

b. 2nd Intermediate Coat: Epoxy applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 3.0 to 8.0 mils.

1) Carboline: 890 2-Component Epoxy.
2) DuPont: 25P High Solids Epoxy Mastic.
3) International: Intergard 345 DTM Semi-Gloss Epoxy.

c. 3rd Coat: Aliphatic polyurethane enamel applied at spreading rate recommended by manufacturer to achieve a dry film thickness of 1.5 to 4.0 mils.

1) Carboline: 134-HS 2-Component Acrylic-Aliphatic Urethane.
2) DuPont: Imron 333 High Gloss Polyurethane Enamel.
3) International: Interthane 990 Low VOC Thin Film Polyurethane.

2.5 SOURCE QUALITY CONTROL

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
1. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" for Exterior platform railings and incorporated systems, stairs, gates, sign frames, brackets and fasteners
2. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning." For platform, canopy, stair/elevator towers - all steel members including columns, beams, purlins, roof framing components and accessories including base plates.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

E. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

F. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

1. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.
2. Brush out and work brush coats into surfaces in an even film.
3. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

4. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.
5. Spray Equipment: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.

    a. Use spray equipment with orifice size recommended by manufacturer for material and texture required.
    b. Apply each coat to provide the equivalent hiding of brush-applied coats.
    c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.

G. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

H. Field Connections: Areas adjacent steel field connections to be delivered to jobsite with primer coat only. See Section: ” FIELD PAINTING ”
1. Shop-apply primer coat to entire component.
2. Mask-off areas around field connections after erection and final torque of connection bolts
3. Touch-up areas of primer coat that have been damaged.
4. Apply finish coats to components, allowing proper feathering of surfaces to obtain a consistent finish.

I. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

J. Completed Work: Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.4 QUALITY CONTROL

A. Dry Film Thickness Testing: Owner will engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and

apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 FIELD PAINTING

A. Summary: Field painting will be limited to connections and minor abrasions from delivery or erection. All other painting is shop-applied.

B. Restrictions: Train schedules and site conditions may necessitate railroad track outages, railroad flagmen, and nighttime work periods for field painting. The Contractor shall pay special attention to the article entitled, "Safety and Protection of the Railroad Traffic and Property", "requirements for Temporary Protection Shields…" and other Amtrak Specifications in the General Provisions.

C. Comply with the provisions of Article M.07 of Form 816 except as otherwise stated specified.
   1 Clean all steel soon after erection of dirt, mud, lubricant or other foreign matter that may have accumulated.
   2. Mask off adjacent painted areas that have already been painted, allowing approximately 1" overlap for feathering.
   2. Prime and Spot paint all field bolts, field welds, and abrasions to the shop coat with the same material used for the shop coat. Use a heavy field coat of bituminous paint on those portions of columns to be embedded in masonry or concrete in the exterior walls, and on interior columns through the slab on grade to be encased in concrete.

D. The ambient air and surface temperature shall be at least 5^0F above the dew point prior to and during coating applications.

3.6 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

END OF SECTION 099600

SECTION 099610 – GRAFFITI CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes: Protective anti graffiti system applied directly to above grade, exterior vertical surfaces indicated, including surface preparation and application.
   1. Substrate applications of water-repellents include:
      a. Pre-cast Concrete surfaces.
      b. Cast-in-Place Concrete.
      c. Brick

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data.

C. M.S.D.S. sheets indicating V.O.C. content and safety pre-cautions.

D. Pre-Installation Conference Report: Submit report verifying project site conditions, approval of jobsite Mock-Up, manufacturer's instructions and requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For qualified Installer.

C. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

D. Warranties: Sample of special warranties.

E. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project. Minimum of Five (5) Years experience in the successful application of anti graffiti coating.

C. Manufacturer Qualifications: Manufacturer with a minimum of Five (5) Years experience in the successful production of anti graffiti technology.

D. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

E. Mock-Up: Install mock-up at project site using acceptable anti graffiti system per manufacturer's instructions. Obtain Engineer/Designer/Owner's approval of system, appearance and workmanship standard. Test a small, remote area to assure desired results. Perform anti graffiti function testing and analysis required prior to installation.
   1. Mock-Up Size: Five (5) feet by Five (5) feet (Minimum).
   2. Mock-Up Substrate: Vertical Wall.
   3. Maintain mock-up during construction for workmanship comparison.
   4. Mock-up may be incorporated into final construction upon Engineer/ Architect/Owner's approval.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 WARRANTY

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Warranty Period: Manufacturer's standard, but not less than 5-years from the issuance of the Certificate of Compliance.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide graffiti control products that are compatible with one another and with substrates under conditions of service and application, as demonstrated by the manufacturer, based on testing and field experience.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. LymTal, Intl., "Iso-Flex 640 WB"
      a. Address: 4150 S. Lapeer Rd., Lake Orion, MI 48359 Telephone: 248-373-8100
      b. Approved Equal

C. Performance Requirements: Anti graffiti products shall meet or exceed the following performance standards:
   1. Percent Active Ingredients - not less than 55%.
   2. Flash Point: ASTM D 3278-82 - Results: Greater than 100 degrees F. (SETA C.C.)
   3. Pot Life: 1-3 hours
   4. Tensile Strength: ASTM D412 – 8000 psi
   5. Ultimate Elongation: ASTM D412 – 20%
   6. Abrasion Resistance: Tabor 1,000 Rev., CS 17 Wheel, 1000 g – 20 mgs.
   7. Impact Resistance: ASTM D2794 – Direct >160 in-lbs, Reverse > 160 in-lbs.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive coatings, with Installer present, for compliance with requirements other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Determine acceptable removal techniques for contaminants harmful to anti graffiti performance, such as dust, dirt, grease, oils, curing compounds, form release agents, laitance, efflorescence, existing films and other water repellent coatings.

3.2 PREPARATION

A. Protect adjacent work areas and finish surfaces from damage during anti graffiti system installation.

B. Prior to installation, clean substrates of substances that could impair penetration or reaction of anti graffiti system. Coordinate cleaning and application to avoid contamination of newly treated surfaces.

C. Substrates shall be clean, dry, sound, and free of contaminants detrimental to anti graffiti system performance.

D. Remove contaminants by method approved at mock-up.

E. Allow cleaned, damp, or water soaked surfaces to become dry before installation.

3.3 INSTALLATION

3.4 Apply anti graffiti system to properly prepared surfaces indicated. Apply material within time restrictions after surface preparation as recommended by manufacturer.

3.5 Apply anti graffiti by rolling or brushing techniques recommended by manufacturer to achieve desired function and results.

3.6 Apply anti graffiti material as demonstrated and approved at jobsite mock-up and not less than manufacturer's minimum recommended coverage rate. Coverages of approximately 100 square feet per gallon can be attained depending on substrate porosity, texture and profile. A second coat should be applied within 24 hours of the first coat. Coverage rates of the second coat will be approximately 125 ft/gallon.

3.7 CLEANING

A. Clean off excess coatings as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of and of products on which coatings are applied.

3.8 PROTECTION

A. Protect surfaces during and after drying period from contact with contaminating substances and from damage resulting from construction operations or other causes so surfaces are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated coatings immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 099610

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Illuminated, fabricated channel dimensional characters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For dimensional letter signs.

   1. Include fabrication and installation details and attachments to other work.
   2. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
   3. Show message list, typestyles, graphic elements, and layout for each sign
   4. Show locations of electrical service connections.
   5. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Sign Schedule: Use same designations specified or indicated on Drawings or in a sign schedule.

E. Delegated-Design Submittal: For signs indicated in "Performance Requirements" Article.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

B. Maintenance data.

1.5 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design sign structure, anchorage, and backlighting system of dimensional character sign type(s) to withstand design loads as indicated on Drawings.

B. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 DIMENSIONAL CHARACTERS

A. Fabricated Channel Characters: Metal face and side returns, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability and for securing fasteners; and as follows.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ACE Sign Systems, Inc.
b. Allen Industries, Inc.; Architectural Division.
c. A. R. K. Ramos Signage Systems.
d. ASI Sign Systems, Inc.
e. Gemini Incorporated.
f. Poblocki Sign Company, LLC.

2. Illuminated Characters: Backlighted character construction with LED lighting including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.

a. Power: 120 V, 60 Hz, 1 phase, 15 A.

3. Character Material: Sheet or plate aluminum.
4. Character Height: 9”.
5. Character Depth: 1 ½”.

6. Finishes:

    a. Integral Aluminum Finish: Clear anodized.

7. Mounting: Projecting studs.

    a. Hold characters at manufacturer's recommended distance from wall surface.

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signage, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

    a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.

4. Sign Mounting Fasteners:

    a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

B. Adhesives: As recommended by sign manufacturer.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
2. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
4. Internally brace signs for stability and for securing fasteners.
5. Provide rebates, lugs, and brackets necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

6. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
   1. Stainless-Steel Brackets: Factory finish brackets with No. 4 finish unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

   1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
   3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

   1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

      a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
      b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

   2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

      a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
      b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION 101419

SECTION 104060 – BENCHES AND TRASH RECEPTACLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:
   a. Benches and trash receptacles furnished and installed in locations indicated on the drawings.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data.

C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
   1. Show mounting details
   2. Show details for grounding wire attachment.

D. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors available.

E. Samples for Verification: For the following bicycle parking rack/s, showing;
   1. The color of the powder coat finish. Prepare 2 inch by 3.5-inch powder coat samples (or larger) from the same material to be used to finish the product.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Compatibility: Provide benches and trash receptacles that are from the same manufacturer's product line.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Do not deliver benches and trash receptacles until platform and canopy work is complete.

C. Store benches and trash receptacles in original undamaged packages and containers until ready for installation. Handle with sufficient care to prevent any scratches or damage to the finish.

1.6 COORDINATION

A. Coordinate sizes and locations of mounting bolts, grounding attachments, and other related units of Work specified in other Sections to ensure that benches can be supported and installed as indicated.

1.7 WARRANTY

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Warranty Period: Manufacturer's standard, but not less than 3-years from the issuance of the Certificate of Compliance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Support Pipes: Horizontal support to be 3" o.d., .120" wall thickness. Vertical support to be 2 ½ o.d. x .120" wall thickness. Support pipes to be surface mounted.

B. Seat: Seat configuration to be constructed per the platform architectural plans. Seats are to be constructed with a wire grid panel and frame. Wires are 5/16", with 1/8" cross wires spaced 2 ½" oc. Frame to be 7/8" x .120 wall thickness steel tube. Straight seats with backs to be 22" wide and 24" deep.

C. Armrests: Armrests to be installed on either end of bench and intermittently between every two (2) seats. Armrests to be constructed of 7/8" o.d., .065 wall thickness tubing, welded to seat support.

D. Blast Resistant Waste Receptacle: 30" outside diameter with brushed finish stainless steel exterior. Provide full formed fiberglass hinged lid with side cut outs (no top opening) and frangible polyethylene liner. Quantity and location per the platform architectural plans.

E. Mounting bolt covers: Provide covers that adequately cover bench mounting plates. Finish to match Support pipes.

F. Finish: Finish on metal to include a rust inhibitor and top coat finish of thermosetting polyester powdercoat that is U.V., chip and flake resistant. Color as specified in the Finish Schedule.

2.2 MANUFACTURERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. "Plexus Collection" by Landscape Forms. (800) 521-2546
   2. Approved Equal.

B. Basis-of-Design Product: Subject to compliance with requirments, provide BlastGard MTR Model 101, by BlastGard International, Inc. (727)592-9400, www.blastgardintl.com, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before installing benches, examine shop-fabricated work for completion and complete work as required, including removal of packing.

B. Ensure that pre-drilled mounting holes are properly aligned with bench mounting plates.

C. Examine surfaces with Installer present, for compliance with requirements other conditions affecting performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Handle and install benches and trash receptacles in accordance with manufacturer's recommendations and installation instructions.

B. Assembly of units to be done in accordance with assembly instructions and hardware provided by manufacturer.

C. Benches should be mechanically secured to platform surfaces with epoxy-set anchor bolts. Coordinate installation of grounding wire with electrical contractor. Refer to bench manufacturer's instructions for addition mounting/securing instructions. Coordinate embed depths with precast steel strands. Utilize full release drill and equipment to ensure that no precast strands are jeopardized.

D. Set benches and trash receptacles level and true to line, in correct relationship to adjacent materials.

3.3 CLEANING

A. Clean benches and trash receptacles with cleaning materials approved in writing by manufacturers.

3.4 PROTECTION

A. Protect surfaces from contact with contaminating substances and from damage resulting from construction operations or other causes so surfaces are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated benches and trash receptacles immediately and replace.

END OF SECTION 104060

SECTION 104070 – BICYCLE PARKING RACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section Includes:
   a. Bicycle Parking Racks furnished and installed in locations indicated on drawings.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data.

C. Samples for Verification: For the following bicycle parking rack/s, showing;
   1. The color of the powder coat finish. Prepare 2 inch by 3.5-inch powder coat samples (or larger) from the same material to be used to finish the product.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Store bicycle parking racks in original undamaged packages and containers until ready for installation.

C. Handle powder coated bicycle parking racks with sufficient care to prevent any scratches or damage to the finish.

1.7 WARRANTY

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Warranty Period: Manufacturer's standard, but not less than 1-year from the issuance of the Certificate of Compliance.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide graffiti control products that are compatible with one another and with substrates under conditions of service and application, as demonstrated by the manufacturer, based on testing and field experience.

2.2 MATERIALS

A. Powder Coating: Triglycidyl isocyanurate (TGIC) powder, a polyester coating.
   1. Color as specified in the Finish Schedule.

B. Heavy Duty Winder: Rack shall be constructed of ASTM A53, 2" Schedule 40 steel pipe (2-3/8" O.D. x 0.154" thick wall (60.3mm x 3.9mm)) or better. Height is 42" (1066.8mm). Rack shall be a minimum of 42" high to provide proper clearance for parked bicycles.

2.3 MANUFACTURERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Bike Security Racks, Inc
   2. Creative Pipe, Inc.
   3. Madrax, Inc.
   4. Approved Equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces with Installer present, for compliance with requirements other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Handle and install bicycle parking racks in accordance with manufacturer’s recommendations and installation instructions.

B. Set bicycle parking racks secured to construction, level and true to line, in correct relationship to adjacent materials.

3.3 CLEANING

A. Clean bicycle racks with cleaning materials approved in writing by manufacturers.

3.4 PROTECTION

A. Protect surfaces from contact with contaminating substances and from damage resulting from construction operations or other causes so surfaces are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated racks immediately and replace.

END OF SECTION 104070

SECTION 104250 – SITE WAYFINDING & IDENTIFICATION SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes the following types of signs:

1. Fabricated Aluminum Post and Panel Signs with Pre-cast concrete footings.
2. Fabricated Station Information Display Case with pre-cast concrete footings and single sided exterior grade display cases.
3. Fabricated Aluminum Post and Panel Signs
4. Fabricated Post and Panel Signs with Ceiling or Canopy Mount
5. Aluminum Sign Panels
6. Zinc Sign Panels with Braille
7. Aluminum Regulatory Sign Panels with Applied Reflective Graphics.
8. Aluminum Regulatory Signs, Post Mounted with Applied Reflective Graphics.

B. Related Sections include the following:

1. Division 3 Section “Cast-In-Place Concrete” for sign foundations.
2. Division 3 Section “Pre-cast Structural Concrete” for ID Sign foundation.
3. Division 5 Section “Pipe and Tube Railings” for railing mounted panel signs

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division I, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816--2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.3 SUBMITTALS:

A. General: Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR—SUBMITTALS.

1. Product data for each sign type specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes. Provide certifications that all work has been designed and installed in accordance with ADA requirements.

2. Shop drawings showing fabrication and mounting methods for each sign type. Include plans, elevations, and large scale sections of typical components. Show anchors, layout, reinforcement, accessories and installation details.

    a. Provide a measured layout for each sign required, and prepare full scale layouts of sample messages showing word and letter spacing.

    b. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed.

    c. Additions or modifications to details, which are necessary due to special conditions encountered during the site survey, shall be provided by the Contractor as part of the contract and at no additional cost to the State.

3. Materials List: Submit complete list of all materials proposed to be furnished and installed under this Section, making all submittals and re-submittals in accordance with the provisions of the Contract Documents and submit a notarized Certificate of Compliance.

4. Samples: Provide the following samples of each sign component for initial selection of color, pattern and surface texture as required and for verification of compliance with requirements indicated.

    a. Submit 4” x 4” color samples of each specified finish including paints, applied vinyl, and aluminum.

    b. Typical mounting brackets.

    c. Submit a complete sample alphabet of each typeface and pictogram specified (1” minimum height).

    d. Submit an 8-1/2” x 11” color print of each specified logotype, to include any modifications as required.

    e. Catalog Cuts: Catalog cuts shall be marked to indicate the item, model, capacities and other characteristics listed in the table or on printed sheets.

5. As part of Shop Drawing submission provide a detailed schedule of proposed times and dates for the installation of signage. Schedule shall be submitted for

review and approval. All work shall be performed in accordance with any modifications affected by train schedule.

1.4 QUALITY ASSURANCE:

A. Sign Fabricator Qualifications: Firm experienced in producing signs similar to those indicated for this project, with a record of successful in-service performance, and sufficient production capacity to produce sign units required without causing delay in the Work.

B. Source Limitations: For each separate sign type required, obtain signs from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

C. Comply with all provisions of the Americans with Disabilities Act of 1990, and the subsequent Department of Justice *2010 ADA Standards for Accessible Design; ANSI A117.1-2003, Accessible and Useable Buildings and Facilities* and all other applicable codes with regard to signage, as well as any and all subsequent appendices, addenda or revisions; all provisions of the *Amtrak Graphic Signage Standards Manual, dated August 1995, revised 2010.*

D. For actual fabrication of the signage package, use only mechanics that are thoroughly trained and experienced in the skills required for the manufacture and fabrication of the units. In acceptance or rejection of the manufactured units, no allowance will be made for lack of skill on the part of the fabricator/manufacturer.

E. Tolerances:

1. Sign Panels

a. The Contractor shall note on the shop drawings all fabrication tolerances including, but not limited to: plumb, thickness, length, width, square-ness, camber, and flat-ness.

b. Signs shall be free of defects including, but not limited to: buckles, dents, warps, wrinkles, and burrs.

2. Messages

a. Message Location: ±1/16 inch from the location as shown.

b. Line-to-Line: ±1/32 inch between each line and ±1/16 inch over entire message.

c. Letter-to-Letter or Symbol (horizontally and vertically): ±1/32 inch between each letter or symbol and ±1/16 inch over an entire line.

3. All sign face panels shall be of a single sheet. Joined pieces will not be accepted.

4. Design components to allow for expansion and contraction for temperatures ranging between -20°F and +100°F, without causing buckling, opening of joints, or overstressing of welds and fasteners.

5. Comply with AWS D1.2 for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welding flux and dress on all exposed and contact surfaces.

6. Mill joints to a tight, hairline fit. Cope or miter corner joints.

F. The Contractor shall have all mounting and fabrication details and calculations designed, stamped and approved by a currently licensed Professional Engineer (PE), and reviewed and approved by the Engineer.

G. Structural Performance: Structural elements shall withstand the effects of gravity, wind, seismic, snow, and ice loads as per the Connecticut State Building Code. At a minimum, the signs must withstand a wind load of 20lbs/sf and horizontal/vertical loads of 250lbs/sf at top center of the sign with a maximum deflection of 1/360 of sign height. Calculations are to be submitted to the Engineer for review.

H. Manufacturer is to provide a five (5) year unconditional guarantee for said units against any defects in workmanship or fabrication.

I. The State reserves the right to retain an independent testing service to inspect the manufacturing process to ensure conformity to the Contract Documents.

J. The Contractor shall have in effect a Quality Assurance (QA) program clearly defining the procedures and requirements necessary to ensure that all aspects of the Work are accomplished in accordance with the Contract Documents. The Contractor will submit a copy of its QA program to the Engineer within fifteen (15) days after receipt of Notice of Award, for review and approval.

K. Minor deviations from the specifications will be accepted to utilize a manufacturer's standard product only when approved in advance on a shop drawing as a substitution and when in the judgment of the Designer such deviations do not materially detract from the Design Concept or the intended performance.

L. The Contractor shall be responsible for the quality of all materials and workmanship required for the execution of this contract, including the materials and workmanship of any firms or individuals who act as its Subcontractors. The Contractor shall be responsible for providing Subcontractors with complete and up-to-date drawings, specifications, message schedules and other information issued by the Designer.

M. No fabrication or installation materials or methods shall be used that will change the visual quality or in any manner have an adverse effect on existing materials and surfaces. The Contractor is responsible for the structural stability of all signs and mounting there-of. All damaged surfaces and materials shall be restored to their original condition and appearance by the Contractor.

1.5 PROJECT CONDITIONS:

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

B. The Contractor shall provide adequate staff to take measurements and notes to determine sign locations and conditions.

1.6 REFERENCES:

A. American Society for Testing Materials (ASTM)

B. American Welding Society (AWS) – Structural Welding Code

C. Americans with Disabilities Act – 1990 and the subsequent Department of Justice *2010 ADA Standards for Accessible Design*

D. ANSI A-1171-2003 – Specifications for Sign Requirements for the Physically Handicapped.

E. Americans with Disabilities Act Architectural Guidelines (ADAAG)

F. Amtrak Graphic Signage Standards Manual, dated August 1995, revised 2010.

1.7 DELIVERY, STORAGE AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver signs in factory-fabricated containers or wrappings, which offer proper protection from construction debris and physical damage.

C. Store items in original wrappings in a clean dry place. Protect from weather, dirt, fumes, and water and other abuses of the environment

D. Handle carefully to prevent damage, breaking and soiling. Do not install damaged units or components, replace with new.

E. Replacements: In the event of damage, repair will be subject to the State's discretion as to whether replacement or repair will be the procedure for damaged units, and to be provided by the Contractor at no additional cost to the State.

1.8 SCHEDULE OF MANUFACTURE:

A. The contractor shall submit a schedule of completion and sequence of delivery. This schedule shall include but not be limited to the following:

1. Preparation of Shop Drawings and review and approval of Shop Drawings.

2. Final approval, manufacture and sequence of delivery, unless otherwise indicated on the approved Construction Schedule.

1.9 DELIVERY OF UNITS:

A. Contractor shall be responsible for handling and storage. The State shall not be responsible until installed and accepted.

1.10 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08 and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Provide a written warranty issued in the name of the State and jointly signed by the supplier stating that the signs have a guaranteed life of five years against fading, spalling, discoloration, staining, gloss reductions, or rusting from date of substantial performance.

1.11 PERMITS:

A. Contractor shall secure and pay for all permits, licenses and approvals necessary for the execution of the contract, in conformance with the rules and regulations pertaining to the performance of the work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with the requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Fabricated Aluminum Post and Panel Signs with Pre-cast concrete footings.

    a. ID Resources, PO Box 127, Peterborough, NH (603) 924-3371
    b. Dura Architectural Signs, Long Island City, NY (718) 706-6400
    c. Advanced Signing LLC, Medway, MA (508) 533-9000

2. Single-sided Exterior Grade Display Cases:

    a. Nelson Harkins, Chicago Illinois, phone 1-800-882-8989
    b. Tablet & Ticket Company, Chicago Illinois, phone 1-800-438-4959
    c. Poblocki & Sons, Milwaukee Wisconsin, phone (414) 453-4010

3. Fabricated Aluminum Post and Panel Signs:

    a. Howard Industries, Fairview, PA
    b. Sign Comp, Comstock Park, Michigan
    c. Admiral Plastics, Cape Girardeau, Missouri

4. Aluminum Regulatory Sign Panels with Applied Vinyl Graphics

    a. Seton Identification Products, Branford, CT
    b. Vulcan Signs, Foley, Alabama
    c. Best Manufacturing Sign Systems, Montrose, Colorado

5. Aluminum Regulatory Signs, Post Mounted with Applied Vinyl Graphics

    a. ID Resources, PO Box 127, Peterborough, NH (603) 924-3371
    b. Dura Architectural Signs, Long Island City, NY (718) 706-6400
    c. Advanced Signing LLC, Medway, MA (508) 533-9000

2.2 MATERIALS:

A. Aluminum:

1. Aluminum sheet shall be of thickness and sizes shown, constructed of alloy and temper recommended by the aluminum producer or finisher for the type of use and finish indicated with not less than the strength and durability properties specified in ASTM B 209 for 5005-H15, or as noted on drawings.

2. Aluminum extrusions shall be of alloy and temper recommended by the manufacturer for the type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B 221 for 6063-T52 ST, or as noted on drawings.

3. All Metal: to be free of stain, warp-age and any defects impairing strength, durability and appearance.

B. Paint:

1. Paint system to be low VOC, ultraviolet inhibited aliphatic acrylic polyurethane applied over pretreatment coating and primers, as appropriate for each sign substrate material. All signs are clear coated with low VOC satin clear unless indicated otherwise on design intent drawings. Colors to match as follows.

    a. Satin AMT Blue = Matthews Paint VOC# SVOC1142SP
    b. Satin Silver = Matthews Paint VOC# MP18073
    c. Satin Scarlet Red = Matthews Paint VOC# 1340SP
    d. Satin White = Matthews Paint VOC# SV202SP
    e. Satin Black = Matthews Paint VOC# SV923SP
    f. Satin Clear Coat = Matthews Paint VOC# Satin Clear 281228

2. Exact identification of all paints to be noted on the shop drawings, with data describing method of application if other than air drying. Paint finish on signs shall be surface sprayed and have a consistent satin finish, free of dirt, grit, mottling, etc. Each paint coat shall contain ultra-violet inhibitors and shall be applied with sufficient time allowed between applications for proper curing. Provide barrier coats over incompatible primers or remove and re-prime as required.

C. Acrylic:

1. Cast acrylic sheet: Provide cast transparent methyl methacrylate monomer plastic sheet with a minimum flexural strength of 16,000 psi when tested according to ASTM D 790 and a minimum allowable continuous service temperature of 80 degrees C. Where sheet material is indicated as “clear,” provide colorless sheet in matte finish, with light transmittance of 92% when tested according to the requirements of ASTM D 1003.

2. All acrylic panels to be free of stain, warp-age and any defects impairing strength, durability and appearance.

3. Finish is to be uniform on face and edges, unless otherwise specified.

4. All colored coatings, including inks and paints and films, for copy and background colors, to be of a type recommended by acrylic manufacturers for optimum adherence to acrylic surface and nonfading for the application intended.

D. Opaque Vinyl Lettering:

1. All opaque vinyl lettering to be die-cut from opaque, non-reflective vinyl film as manufactured by 3M Co., or approved equal. Vinyl shall have a matte finish with a .003 to .006 thickness and shall match colors indicated on drawings. No hand cut letters will be accepted. Messages to be pre-spaced for application on site. Colors shall be as follows:

a. Majestic Blue = Avery Ultimate Cast Opaque Film UC 900-625-O
b. Light Silver Metallic = 3M Scotchcal Controltac Film 180C-220
c. Geranium = 3M Scotchcal Electrocut Film 7725-63
d. White = 3M Scotchcal Electrocut Film 7725-10
e. Black = 3M Scotchcal Electrocut Film 7725-12

E. Reflective Vinyl Lettering:

1. Reflective Vinyl Lettering: All reflective vinyl lettering to be 3M Company, or approved equal, engineering grade reflective vinyl with clear pressure sensitive adhesive backing and carry a minimum 5 year material warranty. Letters to con -form with the specified typeface. Colors shall be as follows:

a. White = 3M Scotchlite Reflective Vinyl 680-10
b. Black = 3M 3M Scotchlite Reflective Vinyl 680-85
c. Ruby Red =3M Scotchlite Reflective Vinyl 680-82

F. Mounting Materials:

1. Mechanical Mounting: Corrosion resistant fasteners of a type recommended by the manufacturer for use in the type of substrate encountered at each location.

2. Adhesives: Where adhesive mounting techniques are required, the Contractor shall use adhesives specifically designed for compatibility with the base materials and the desired adhesive strength in accordance with recommendations made by the manufacturer of the materials specified to be laminated or adhered. No adhesives that will fade, discolor or de-laminate as a result of proximity to ultraviolet light source or heat or cold shall be used. No adhesives shall change the color or deteriorate the materials to which they are applied. All adhesives shall be of a non-staining, non-yellowing quality and all visible joints shall be free from air bubbles and other defects. All adhesives shall be tested on site. All adhesives shall be indicated in the shop drawings.

G. Welding:

1. Fabrication shall be accomplished using the highest standards of workmanship. All pieces shall be cut and carefully fit together. All visible connections shall be full welded and ground smooth. All visible surfaces and connections shall be without visible grounding marks, surface differentiation or variation.

2. All metal to be free of stain, warp-age and any defects impairing strength, durability and appearance.

3. All welds to comply with the recommendations of the AWS.

H. Fasteners:

1. Use concealed fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.

I. Anchors and Inserts:

1. Use nonferrous metal or hot-dipped galvanized anchors and inserts as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled in place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.3 GRAPHIC PROCESS TYPES:

A. Applied Vinyl:

1. All vinyl lettering to be reflective or opaque, as noted on the drawings, and to be die-cut.

2. No hand cut letters will be accepted.

3. Messages to be pre-spaced for application on site.

2.4 GRAPHIC REQUIREMENTS:

A. Typeface: The typefaces shall conform to the type specifications in this sign package. Alternate type will not be accepted. Type for signs shall match Adobe Type Library fonts (Adobe Systems, Inc.):

1. Frutiger 55 Roman

2. Frutiger 65 Bold

B. Letter and Word Spacing: shall be optical but in conformance with the examples shown on the drawings.

C. All Letterforms: shall be aligned to maintain a baseline parallel to the sign format.

D. Letter Size: to be determined by the height of the upper case ‘E’ of the letterform.

E. Messages: on drawings are for demonstration purposes only. In all cases refer to the Sign Schedule for messages to be used on the finished signs.

F. Symbols are based on the *“System of Passenger/Pedestrian Orientation Symbols”* developed for the Department of Transportation by the American Institute of Graphic Arts and the Society of Environmental Graphic Design’s symbols of accessibility, unless otherwise specified in the *Amtrak Graphic Signage Standards Manual, dated August 1995, revised 2010.*

2.5 FABRICATION:

A. Fabricate Sign Units of graphic process, design, copy, dimensions and color indicated or specified.

B. Copy shall be as stated in message schedule.

1. Confirm "TBD", to be determined, information before fabrication.

C. Artwork:

1. All artwork, unless specifically noted otherwise, shall be the sole responsibility of the Contractor.

2. Where noted on the drawings, the Contractor shall coordinate and obtain from BrandManagement@amtrak.com, authorized artwork of the Amtrak brandmark; and from CTDOT, authorized artwork of the Connecticut Commuter Rail logo, for reference only. Creation of production ready artwork is the sole responsibility of the contractor.

3. Full size color proofs of all artwork, printed on high quality paper, to be submitted for approval prior to fabrication.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION:

A. The locations of signs shown on the drawings are for general information only. It is the responsibility of the Contractor to coordinate with the Owner to determine final locations of signs in the field.

B. The Designer shall be notified of any discrepancies in the drawings, in field dimensions or conditions and/or changes in construction drawings prior to fabrication and/or installation.

C. The Contractor shall examine the areas and conditions under which work of this section is to be performed and correct any conditions detrimental to the timely and proper completion of the work.

D. The Contractor shall not install signs until adjacent finish work is completed.

3.2 INSTALLATION:

A. Installation of components to be in compliance with manufacturer's instructions, unless otherwise specified.

B. Signs shall be installed level and plumb with the orientation shown on the drawings, unless directed otherwise by the owner, with sign surfaces free from distortion or other defects in appearance.

C. Exposed surfaces of fasteners should be field coated with paint to match the surrounding surface color; exposed threads to be protected from paint to allow future maintenance of signs.

D. Anchor bolts and nuts to be coated with corrosion-resistant grease to allow future maintenance of signs.

E. Contractor to provide repair and touch up prior to and after punch list inspection.

F. Contractor to be responsible for the removal of all crating and debris from the project site upon completion.

3.3 CLEANING AND PROTECTION:

A. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect signs from damage until acceptance by the State.

NHHS / Wallingford
Site
Wallingford, CT

Type	Description	Comments
A11	Station Information Display Case	
C1	Designated HC Drop-off and Pick-up	
C2	Passenger Drop-off and Pick-up	
C3	Vehicular Directional (1) Message	
C7	Freestanding Site Identifier	
N	Parking Area Patrolled	
R	Buses Only	
S	Low-Emitting Vehicles	
T	Electric Vehicle Charging Station	

NHHS / Wallingford
Site Signs
Wallingford, CT

Type	Tag	Level	Message side "A"	Message side "B"	Comments
A11	A11-01	SITE	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	
A11	A11-02	SITE	(Amtrak Symbol) AMTRAK Wallingford, CT 1-800-USA-RAIL Amtrak.com	(Amtrak Symbol) AMTRAK Wallingford, CT Thank you for choosing Amtrak. For more information: 1-800-USA-RAIL Amtrak.com	
A11 Count	1				
C1	C1-01	SITE	 Reserved Drop-off and Pick-up	(none)	
C1	C1-02	SITE	 Reserved Drop-off and Pick-up	(none)	
C1 Count	2				
C2	C2-01	SITE	(Amtrak Passenger Drop-off and Pick-up Symbol) Passenger Drop-off and Pick-up Driver Must Remain in Car	(none)	
C2	C2-02	SITE	(Amtrak Passenger Drop-off and Pick-up Symbol) Passenger Drop-off and Pick-up Driver Must Remain in Car	(none)	

NHHS / Wallingford
Site Signs
Wallingford, CT

C2	C2-03	SITE	(Amtrak Passenger Drop-off and Pick-up Symbol) Passenger Drop-off and Pick-up Driver Must Remain in Car	(none)	
C2	C2-04	SITE	(Amtrak Passenger Drop-off and Pick-up Symbol) Passenger Drop-off and Pick-up Driver Must Remain in Car	(none)	
C2 Count	4				
C3	C3-01	SITE	→ (Train Symbol) ♿ Station	← (Train Symbol) ♿ Station	
C3	C3-02	SITE	→ (Train Symbol) ♿ Station	(none)	
C3 Count	2				
C7	C7-01	SITE	(Amtrak Symbol) AMTRAK Wallingford Station For Information: 1-800-USA-RAIL Amtrak.com	(Amtrak Symbol) AMTRAK Wallingford Station For Information: 1-800-USA-RAIL Amtrak.com	
C7	C7-02	SITE	(Amtrak Symbol) AMTRAK Wallingford Station For Information: 1-800-USA-RAIL Amtrak.com	(Amtrak Symbol) AMTRAK Wallingford Station For Information: 1-800-USA-RAIL Amtrak.com	

NHHS / Wallingford
Site Signs
Wallingford, CT

C7	C7-03		(Amtrak Symbol) AMTRAK Wallingford Station For Information: 1-800-USA-RAIL Amtrak.com	(Amtrak Symbol) AMTRAK Wallingford Station For Information: 1-800-USA-RAIL Amtrak.com	
C7 Count	3				
N	N01	SITE	NOTICE ---------- THIS PARKING AREA PATROLLED	(none)	CTDOT STREET POST
N	N02	SITE	NOTICE ---------- THIS PARKING AREA PATROLLED	(none)	CTDOT STREET POST
N	N03	SITE	NOTICE ---------- THIS PARKING AREA PATROLLED	(none)	CTDOT STREET POST
N Count	3				
R	R01	SITE	BUSES ONLY Ⓡ VIOLATORS TOWED	(none)	CTDOT STREET POST
R	R02	SITE	BUSES ONLY Ⓡ VIOLATORS TOWED	(none)	CTDOT STREET POST
R Count	2				
S	S01	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S	S02	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST

NHHS / Wallingford
Site Signs
Wallingford, CT

S	S03	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S	S04	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S	S05	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S	S06	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S	S07	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S	S08	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S	S09	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S	S10	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
S Count	10				

NHHS / Wallingford
Site Signs
Wallingford, CT

T	T01	SITE	(charging station symbol) ELECTRIC VEHICLE CHARGING STATION	(none)	CTDOT STREET POST
T	T02		(charging station symbol) ELECTRIC VEHICLE CHARGING STATION	(none)	CTDOT STREET POST
Y Count	2				

NHHS / Wallingford
Platform-Bridge
Wallingford, CT

Type	Description	Comments
A1a	Branded City Identifier	
A3	Track Identifier	
A9	Directional Stacked	
A11	Station Information Display Case	
A12	ADA City Identifier	
B1	Overhead Directional (1) Message	
B2	Overhead Directional (2) Messages	
B15.1	Area of Refuge	
B15.2	Accessible Route	
B19	Permanent Room Identifier	
C20	ADA Station Entrance Identifier	
D1	No Smoking	
D2.1	In Case of Fire	
D2.2	Smoke Free Facility	
D4	Platform End Restrictive Sign	
D6	Unattended Baggage	

NHHS / Wallingford
Platform-Bridge Signs
Wallingford, CT

Type	Tag	Level	Message side "A"	Message side "B"	Comments
A1a	A1a-01	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT	(Amtrak Symbol) AMTRAK Wallingford, CT	Rail Mounted
A1a	A1a-02	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT	(Amtrak Symbol) AMTRAK Wallingford, CT	Rail Mounted
A1a	A1a-03	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT	(Amtrak Symbol) AMTRAK Wallingford, CT	Rail Mounted
A1a	A1a-04	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT	(Amtrak Symbol) AMTRAK Wallingford, CT	Rail Mounted
A1a	A1a-05	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT	(Amtrak Symbol) AMTRAK Wallingford, CT	Rail Mounted
A1a	A1a-06	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT	(Amtrak Symbol) AMTRAK Wallingford, CT	Rail Mounted
A1a	A1a-07	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT	(Amtrak Symbol) AMTRAK Wallingford, CT	Rail Mounted
A1a Count	7				
A3	A3-01	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-02	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-03	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-04	PLAT	Track 1	Track 1	Canopy Mounted
A3	A3-05	PLAT	Track 1	Track 1	Canopy Mounted
A3	A3-06	PLAT	Track 1	Track 1	Canopy Mounted
A3 Count	6				
A9	A9-01	PLAT	(Buses) (Pass. PU/DO) → Exit	(none)	Rail Mounted
A9	A9-02	PLAT	(Buses) (Pass. PU/DO) → Exit	(none)	Rail Mounted
A9	A9-03	PLAT	(Buses) (Pass. PU/DO) → Exit	(none)	Rail Mounted
A9	A9-04	PLAT	← (Pass.PU/DO) Exit	(none)	Rail Mounted
A9	A9-05	PLAT	← (Pass.PU/DO) Exit	(none)	Rail Mounted

NHHS / Wallingford
Platform-Bridge Signs
Wallingford, CT

A9	A9-06	PLAT	(Pass. PU/DO) ♿ → Exit	(none)	Rail Mounted
A9	A9-07	PLAT	(Pass. PU/DO) ♿ → Exit	(none)	Rail Mounted
A9 Count	7				
A11	A11-01	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Wall Mounted
A11	A11-02	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT 1-800-USA-RAIL Amtrak.com	(none)	Wall Mounted
A11	A11-03	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Wall Mounted
A11	A11-04	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT 1-800-USA-RAIL Amtrak.com	(none)	Wall Mounted
A11	A11-05	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Platform Mounted
A11	A11-06	PLAT	(Amtrak Symbol) AMTRAK Wallingford, CT 1-800-USA-RAIL Amtrak.com	(none)	Platform Mounted
A11 Count	6				
A12	A12-01	PLAT	WALLINGFORD, CT (Grade 2 Braille)	(none)	Wall Mounted
A12	A12-02	PLAT	WALLINGFORD, CT (Grade 2 Braille)	(none)	Wall Mounted
A12 Count	2				
B1	B1-01	BRIDGE	↑ 🚻 ♿ To Track 2	(none)	Glass Wall Mount above door backer panel
B1	B1-02	BRIDGE	↑ 🚻 ♿ To Track 1	(none)	Glass Wall Mount above door backer panel
B1 Count	2				
B2	B2-01	PLAT	↑ 🚻 ♿ To Track 1 → ♿ To Track 2	(none)	Wall Mounted

NHHS / Wallingford
Platform-Bridge Signs
Wallingford, CT

B2	B2-02	PLAT	↑ To Track 2 ← To Track 1	(none)	Wall Mounted
B2	B2-03	BRIDGE	↓ To Track 2 → To Track 1	(none)	Wall Mounted
B2	B2-04	BRIDGE	↓ To Track 1 ← To Track 2	(none)	Wall Mounted
B2 Count	4				
B15.1	B15.1-01	BRIDGE	Area of Refuge	(none)	Wall Mounted
B15.1	B15.1-02	BRIDGE	Area of Refuge	(none)	Wall Mounted
B15.1 Count	2				
B15.2	B15.2-01	PLAT	←	(none)	Rail Mounted
B15.2	B15.2-02	PLAT	→	(none)	Post Mounted
B15.2	B15.2-03	PLAT	→	(none)	Wall Mounted
B15.2	B15.2-04	PLAT	←	(none)	Wall Mounted
B15.2	B15.2-05	PLAT	←	(none)	Wall Mounted
B15.2	B15.2-06	PLAT	→	(none)	Wall Mounted
B15.2	B15.2-07	PLAT	→	(none)	Rail Mounted

NHHS / Wallingford
Platform-Bridge Signs
Wallingford, CT

B15.2	B15.2-08	PLAT	♿ ←	(none)	Wall Mounted
B15.2	B15.2-09	PLAT	♿ ←	(none)	Wall Mounted
B15.2	B15.2-10	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-11	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-12	PLAT	♿ ←	(none)	Wall Mounted
B15.2	B15.2-13	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-14	PLAT	♿ ←	(none)	Rail Mounted
B15.2	B15.2-15	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-16	PLAT	♿ ←	(none)	Rail Mounted
B15.2	B15.2-17	BRIDGE	♿ ↑	(none)	Wall Mounted
B15.2	B15.2-18	BRIDGE	♿ ↑	(none)	Wall Mounted
B15.2 Count	18				
B19	B19-01	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-02	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted

NHHS / Wallingford
Platform-Bridge Signs
Wallingford, CT

B19	B19-03	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-04	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-05	BRIDGE	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-06	BRIDGE	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19 Count	6				
C20	C20-01	PLAT	WALLINGFORD STATION (Grade 2 Braille)	(none	Wall Mounted
C20 Count	1				
D1	D1-01	PLAT		(none)	Rail Mounted
D1	D1-02	PLAT		(none)	Rail Mounted
D1	D1-03	PLAT		(none)	Rail Mounted
D1	D1-04	PLAT		(none)	Rail Mounted
D1	D1-05	PLAT		(none)	Rail Mounted
D1	D1-06	PLAT		(none)	Rail Mounted
D1	D1-07	PLAT		(none)	Rail Mounted
D1 Count	7				
D2.1	D2.1-01	PLAT	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1	D2.1-02	PLAT	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1	D2.1-03	BRIDGE	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted

NHHS / Wallingford
Platform-Bridge Signs
Wallingford, CT

D2.1	D2.1-04	BRIDGE	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1 Count	4				
D2.2	D2.2-01	PLAT	 This is a Smoke-Free Facility	(none)	Wall Mounted
D2.2 Count	1				
D4	D4-01	PLAT	(Exclamation Point Symbol) AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Rail Mounted
D4 Count	1				
D6	D6-01	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-02	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-03	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-04	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-05	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted

NHHS / Wallingford
Platform-Bridge Signs
Wallingford, CT

D6	D6-06	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-07	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6 Count	7				

NHHS / Meriden
Site
Meriden, CT

Type	Description	Comments
C1	Designated HC Drop-off and Pick-up	
C2	Passenger Drop-off and Pick-up	
C4	Vehicular Directional (2) Messages	
C7	Freestanding Site Identifier	
N	Parking Area Patrolled	
R	Buses Only	
S	Taxis Only	
X	Low-Emitting Vehicles	
Y	Electric Vehicle Charging Station	

NHHS / Meriden
Site Signs
Meriden, CT

Type	Tag	Level	Message side "A"	Message side "B"	Comments
C1	C1-01	SITE	♿ Reserved Drop-off and Pick-up	(none)	Flag Mounted
C1 Count	1				
C2	C2-01	SITE	(Amtrak Passenger Drop-off and Pick-up Symbol) Passenger Drop-off and Pick-up Driver Must Remain in Car	(none)	Flag Mounted
C2	C2-02	SITE	(Amtrak Passenger Drop-off and Pick-up Symbol) Passenger Drop-off and Pick-up Driver Must Remain in Car	(none)	Flag Mounted
C2 Count	2				
C4	C4-01	SITE	← P Parking ← Exit		
C4	C4-02	SITE	↑ (Amtrak Passenger Drop Off and Pick up Symbol) Passenger Drop -off / Pick-up → P Parking		
C4 Count	2				

NHHS / Meriden
Site Signs
Meriden, CT

C7	C7-01		(Amtrak Symbol) AMTRAK Meriden Station For Information: 1-800-USA-RAIL Amtrak.com	(Amtrak Symbol) AMTRAK Meriden Station For Information: 1-800-USA-RAIL Amtrak.com	
C7	C7-02		(Amtrak Symbol) AMTRAK Meriden Station For Information: 1-800-USA-RAIL Amtrak.com	(Amtrak Symbol) AMTRAK Meriden Station For Information: 1-800-USA-RAIL Amtrak.com	
C7 Count	2				
N	N01	SITE	NOTICE ---------- THIS PARKING AREA PATROLLED	(none)	CTDOT STREET POST
N	N02	SITE	NOTICE ---------- THIS PARKING AREA PATROLLED	(none)	CTDOT STREET POST
N Count	2				
R	R01	SITE	BUSES ONLY Ⓡ VIOLATORS TOWED	(none)	CTDOT STREET POST
R	R02	SITE	BUSES ONLY Ⓡ VIOLATORS TOWED	(none)	CTDOT STREET POST

NHHS / Meriden
Site Signs
Meriden, CT

R	R03	SITE	BUSES ONLY (R) VIOLATORS TOWED		CTDOT STREET POST
R	R04	SITE	BUSES ONLY (R) VIOLATORS TOWED		CTDOT STREET POST
R	R05	SITE	BUSES ONLY (R) VIOLATORS TOWED		CTDOT STREET POST
R	R06	SITE	BUSES ONLY (R) VIOLATORS TOWED		CTDOT STREET POST
R	R07	SITE	BUSES ONLY (R) VIOLATORS TOWED		CTDOT STREET POST
R Count	7				
S	S01	SITE	TAXI STAND (R) VIOLATORS TOWED	(none)	CTDOT STREET POST
S	S02	SITE	TAXI STAND (R) VIOLATORS TOWED	(none)	CTDOT STREET POST
S Count	2				
X	X01	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
X	X02	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST

NHHS / Meriden
Site Signs
Meriden, CT

X Count	2				
Y	Y01	SITE	(charging station symbol) ELECTRIC VEHICLE CHARGING STATION	(none)	CTDOT STREET POST
Y	Y02		(charging station symbol) ELECTRIC VEHICLE CHARGING STATION	(none)	CTDOT STREET POST
Y Count	2				

NHHS / Meriden
Platform-Bridge
Meriden, CT

Type	Description	Comments
A1a	Branded City Identifier	
A3	Track Identifier	
A9	Directional Stacked	
A11	Station Information Display Case	
A12	ADA City Identifier	
B1	Overhead Directional (1) Message	
B2	Overhead Directional (2) Messages	
B15.1	Area of Refuge	
B15.2	Accessible Route	
B19	Permanent Room Identifier	
C20	ADA Station Entrance Identifier	
D1	No Smoking	
D2.1	In Case of Fire	
D2.2	Smoke Free Facility	
D4	Platform End Restrictive Sign	
D6	Unattended Baggage	

NHHS / Meriden
Platform-Bridge Signs
Meriden, CT

Type	Tag	Level	Message side "A"	Message side "B"	Comments
A1a	A1a-01	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT	(Amtrak Symbol) AMTRAK Meriden, CT	Rail Mounted
A1a	A1a-02	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT	(Amtrak Symbol) AMTRAK Meriden, CT	Rail Mounted
A1a	A1a-03	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT	(Amtrak Symbol) AMTRAK Meriden, CT	Rail Mounted
A1a	A1a-04	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT	(Amtrak Symbol) AMTRAK Meriden, CT	Rail Mounted
A1a	A1a-05	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT	(Amtrak Symbol) AMTRAK Meriden, CT	Rail Mounted
A1a	A1a-06	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT	(Amtrak Symbol) AMTRAK Meriden, CT	Rail Mounted
A1a	A1a-07	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT	(Amtrak Symbol) AMTRAK Meriden, CT	Rail Mounted
A1a Count	7				
A3	A3-01	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-02	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-03	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-04	PLAT	Track 1	Track 1	Canopy Mounted
A3	A3-05	PLAT	Track 1	Track 1	Canopy Mounted
A3	A3-06	PLAT	Track 1	Track 1	Canopy Mounted
A3	A3-07	PLAT	Track 1	Track 1	Canopy Mounted
A3 Count	7				
A9	A9-01	PLAT	(Buses/Taxis) (Pass. PU/DO) ♿ → Exit	(none)	Rail Mounted
A9	A9-02	PLAT	(Buses/Taxis) (Pass. PU/DO) ♿ → Exit	(none)	Rail Mounted
A9	A9-03	PLAT	(Buses/Taxis) (Pass. PU/DO) ♿ → Exit	(none)	Rail Mounted
A9	A9-04	PLAT	(Buses/Taxis) (Pass. PU/DO) ♿ → Exit	(none)	Rail Mounted

NHHS / Meriden
Platform-Bridge Signs
Meriden, CT

A9	A9-05	PLAT	← ♿ (Buses/Taxis) (Pass.PU/DO) Exit	(none)	Rail Mounted
A9	A9-06	PLAT	← ♿ (Buses/Taxis) (Pass.PU/DO) Exit	(none)	Rail Mounted
A9	A9-07	PLAT	← ♿ (Buses/Taxis) (Pass.PU/DO) Exit	(none)	Rail Mounted
A9	A9-08	PLAT	(Buses/Taxis) (Pass. PU/DO) ♿ → Exit	(none)	Rail Mounted
A9 Count	8				
A11	A11-01	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Wall Mounted
A11	A11-02	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT 1-800-USA-RAIL Amtrak.com	(none)	Wall Mounted
A11	A11-03	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Platform Mounted
A11	A11-04	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT 1-800-USA-RAIL Amtrak.com	(none)	Platform Mounted
A11	A11-05	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Platform Mounted
A11	A11-06	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT 1-800-USA-RAIL Amtrak.com	(none)	Platform Mounted
A11	A11-07	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Wall Mounted

NHHS / Meriden
Platform-Bridge Signs
Meriden, CT

A11	A11-08	PLAT	(Amtrak Symbol) AMTRAK Meriden, CT 1-800-USA-RAIL Amtrak.com	(none)	Wall Mounted
A11 Count	8				
A12	A12-01	PLAT	MERIDEN, CT (Grade 2 Braille)	(none)	Wall Mounted
A12	A12-02	PLAT	MERIDEN, CT (Grade 2 Braille)	(none)	Wall Mounted
A12 Count	2				
B1	B1-01	BRIDGE	↑ To Track 2	(none)	Glass Wall Mounted Above Door Backer Panel
B1	B1-02	BRIDGE	↑ To Track 1	(none)	Glass Wall Mounted Above Door Backer Panel
B1 Count	2				
B2	B2-01	PLAT	↑ To Track 1 ← To Track 2	(none)	Wall Mounted
B2	B2-02	PLAT	↑ To Track 2 → To Track 1	(none)	Wall Mounted
B2	B2-03	BRIDGE	↓ To Track 2 ← To Track 1	(none)	Wall Mounted
B2	B2-04	BRIDGE	↓ To Track 1 → To Track 2	(none)	Wall Mounted
B2 Count	4				
B15.1	B15.1-01	BRIDGE	Area of Refuge	(none)	Wall Mounted
B15.1	B15.1-02	BRIDGE	Area of Refuge	(none)	Wall Mounted
B15.1 Count	2				

NHHS / Meriden
Platform-Bridge Signs
Meriden, CT

B15.2	B15.2-01	PLAT	♿ →	(none)	Post Mounted
B15.2	B15.2-02	PLAT	♿ ←	(none)	Rail Mounted
B15.2	B15.2-03	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-04	PLAT	♿ →	(none)	Post Mounted
B15.2	B15.2-05	PLAT	♿ ←	(none)	Wall Mounted
B15.2	B15.2-06	PLAT	♿ ←	(none)	Wall Mounted
B15.2	B15.2-07	PLAT	♿ →	(none)	Rail Mounted
B15.2	B15.2-08	PLAT	♿ →	(none)	Rail Mounted
B15.2	B15.2-09	PLAT	♿ ←	(none)	Post Mounted
B15.2	B15.2-10	PLAT	♿ ←	(none)	Rail Mounted
B15.2	B15.2-11	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-12	PLAT	♿ ←	(none)	Wall Mounted
B15.2	B15.2-13	PLAT	♿ ←	(none)	Wall Mounted

NHHS / Meriden
Platform-Bridge Signs
Meriden, CT

B15.2	B15.2-14	PLAT		(none)	Rail Mounted
B15.2	B15.2-15	PLAT		(none)	Post Mounted
B15.2	B15.2-16	BRIDGE		(none)	Wall Mounted
B15.2	B15.2-17	BRIDGE		(none)	Wall Mounted
B15.2 Count	17				
B19	B19-01	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-02	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-03	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-04	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-05	BRIDGE	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-06	BRIDGE	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19 Count	6				
C20	C20-01	PLAT	MERIDEN STATION (Grade 2 Braille)	(none)	Wall Mounted
C20 Count	1				
D1	D1-01	PLAT		(none)	Rail Mounted
D1	D1-02	PLAT		(none)	Rail Mounted
D1	D1-03	PLAT		(none)	Rail Mounted
D1	D1-04	PLAT		(none)	Rail Mounted
D1	D1-05	PLAT		(none)	Rail Mounted

NHHS / Meriden
Platform-Bridge Signs
Meriden, CT

D1	D1-06	PLAT		(none)	Rail Mounted
D1	D1-07	PLAT		(none)	Rail Mounted
D1	D1-08	PLAT		(none)	Rail Mounted
D1 Count	8				
D2.1	D2.1-01	PLAT	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1	D2.1-02	PLAT	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1	D2.1-03	BRIDGE	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1	D2.1-04	BRIDGE	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1 Count	4				
D2.2	D2.2-01	PLAT	 This is a Smoke-Free Facility	(none)	Wall Mounted
D2.2 Count	1				
D4	D4-01	PLAT	(Exclamation Point Symbol) AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Rail Mounted
D4 Count	1				
D6	D6-01	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted

NHHS / Meriden
Platform-Bridge Signs
Meriden, CT

D6	D6-02	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Wall Mounted
D6	D6-03	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-04	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-05	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-06	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-07	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-08	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6 Count	8				

NHHS /Berlin
Site
Berlin, CT

Type	Site	Comments
C3	Vehicular Directional (1) Message	
C7	Freestanding Site Identifier	
N	Parking Area Patrolled	
R	Low-Emitting Vehicles	
S	Electric Vehicle Charging Station	

NHHS / Berlin
Site Signs
Berlin, CT

Type	Tag	Level	Message side "A"	Message side "B"	Comments
C3	C3-01	SITE	← (Train ♿ Walkway to Station Symbol)	→ (Train ♿ Walkway to Station Symbol)	
C3	C3-02	SITE	← (Train ♿ Walkway to Station Symbol)	→ (Train ♿ Walkway to Station Symbol)	
C3 Count	2				
C7	C7-01	SITE	(Amtrak Symbol) AMTRAK Berlin Station For Information: 1-800-USA-RAIL Amtrak.com	(Amtrak Symbol) AMTRAK Berlin Station For Information: 1-800-USA-RAIL Amtrak.com	
C7 Count	1				
N	N01	SITE	NOTICE ---------- THIS PARKING AREA PATROLLED	(none)	CTDOT STREET POST
N	N02	SITE	NOTICE ---------- THIS PARKING AREA PATROLLED	(none)	CTDOT STREET POST
N	N03	SITE	NOTICE ---------- THIS PARKING AREA PATROLLED	(none)	CTDOT STREET POST
N Count	3				
R	R01	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R	R02	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R	R03	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST

NHHS / Berlin
Site Signs
Berlin, CT

R	R04	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R	R05	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R	R06	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R	R07	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R	R08	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R	R09	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R	R10	SITE	LOW-EMITTING AND FUEL EFFICIENT PARKING ONLY	(none)	CTDOT STREET POST
R Count	10				
S	S01	SITE	(charging station symbol) ELECTRIC VEHICLE CHARGING STATION	(none)	CTDOT STREET POST
S	S02		(charging station symbol) ELECTRIC VEHICLE CHARGING STATION	(none)	CTDOT STREET POST

NHHS / Berlin
Site Signs
Berlin, CT

S Count	2				

NHHS / Berlin
Platform-Bridge
Berlin, CT

Type	Description	Comments
A1a	Branded City Identifier	
A3	Track Identifier	
A9	Directional Stacked	
A11	Station Information Display Case	
A12	ADA City Identifier	
B1	Overhead Directional (1) Message	
B2	Overhead Directional (2) Messages	
B15.1	Area of Refuge	
B15.2	Accessible Route	
B19	Permanent Room Identifier	
C20	ADA Station Entrance Identifier	
D1	No Smoking	
D2.1	In Case of Fire	
D2.2	Smoke Free Facility	
D4	Platform End Restrictive Sign	
D6	Unattended Baggage	

NHHS / Berlin
Platform-Bridge Signs
Berlin, CT

Type	Tag	Level	Message side "A"	Message side "B"	Comments
A1a	A1a-01	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT	(Amtrak Symbol) AMTRAK Berlin, CT	Canopy Mounted
A1a	A1a-02	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT	(Amtrak Symbol) AMTRAK Berlin, CT	Rail Mounted
A1a	A1a-03	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT	(Amtrak Symbol) AMTRAK Berlin, CT	Rail Mounted
A1a	A1a-04	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT	(Amtrak Symbol) AMTRAK Berlin, CT	Rail Mounted
A1a	A1a-05	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT	(Amtrak Symbol) AMTRAK Berlin, CT	Canopy Mounted
A1a	A1a-06	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT	(Amtrak Symbol) AMTRAK Berlin, CT	Rail Mounted
A1a Count	6				
A3	A3-01	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-02	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-03	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-04	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-05	PLAT	Track 2	Track 2	Canopy Mounted
A3	A3-06	PLAT	Track 1	Track 1	Canopy Mounted
A3	A3-07	PLAT	Track 1	Track 1	Canopy Mounted
A3	A3-08	PLAT	Track 1	Track 1	Canopy Mounted
A3	A3-09	PLAT	Track 1	Track 1	Canopy Mounted
A3 Count	9				
A9	A9-01	PLAT	← ♿ 🚻 Exit	(none)	Rail Mounted
A9	A9-02	PLAT	← ♿ 🚻 Exit	(none)	Rail Mounted
A9	A9-03	PLAT	🚻 ♿ → Exit	(none)	Rail Mounted
A9	A9-04	PLAT	← ♿ 🚻 Exit	(none)	Rail Mounted

NHHS / Berlin
Platform-Bridge Signs
Berlin, CT

A9	A9-05	PLAT	← ♿ 🚻 Exit	(none)	Rail Mounted
A9	A9-06	PLAT	🚻 ♿ → Exit	(none)	Rail Mounted
A9 Count	6				
A11	A11-01	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Platform Mounted
A11	A11-02	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT 1-800-USA-RAIL Amtrak.com	(none)	Platform Mounted
A11	A11-03	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Wall Mounted
A11	A11-04	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT 1-800-USA-RAIL Amtrak.com	(none)	Wall Mounted
A11	A11-05	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Wall Mounted
A11	A11-06	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT 1-800-USA-RAIL Amtrak.com	(none)	Wall Mounted
A11	A11-07	PLAT	(CT RAIL LOGO AND SUPPLEMENTAL INFORMATION)	(none)	Platform Mounted
A11	A11-08	PLAT	(Amtrak Symbol) AMTRAK Berlin, CT 1-800-USA-RAIL Amtrak.com	(none)	Platform Mounted
A11 Count	8				
A12	A12-01	PLAT	BERLIN, CT (Grade 2 Braille)	(none)	Wall Mounted
A12	A12-02	PLAT	BERLIN, CT (Grade 2 Braille)	(none)	Wall Mounted

NHHS / Berlin
Platform-Bridge Signs
Berlin, CT

A12 Count	2				
B1	B1-01	BRIDGE	↑ To Track 2	(none)	Glass Wall Mount above door backer panel
B1	B1-02	BRIDGE	↑ To Track 1	(none)	Glass Wall Mount above door backer panel
B1 Count	2				
B2	B2-01	PLAT	↑ To Track 1 ← To Track 2	(none)	Wall Mounted
B2	B2-02	PLAT	↑ To Track 2 → To Track 1	(none)	Wall Mounted
B2	B2-03	BRIDGE	↓ To Track 2 ← To Track 1	(none)	Wall Mounted
B2	B2-04	BRIDGE	↓ To Track 1 → To Track 2	(none)	Wall Mounted
B2 Count	4				
B15.1	B15.1-01	BRIDGE	Area of Refuge	(none)	Wall Mounted
B15.1	B15.1-02	BRIDGE	Area of Refuge	(none)	Wall Mounted
B15.1 Count	2				
B15.2	B15.2-01	PLAT	→ (accessible)	(none)	Post Mounted
B15.2	B15.2-02	PLAT	← (accessible)	(none)	Wall Mounted
B15.2	B15.2-03	PLAT	→ (accessible)	(none)	Rail Mounted

NHHS / Berlin
Platform-Bridge Signs
Berlin, CT

B15.2	B15.2-04	PLAT	♿ ←	(none)	Rail Mounted
B15.2	B15.2-05	PLAT	♿ →	(none)	Post Mounted
B15.2	B15.2-06	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-07	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-08	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-09	PLAT	♿ ←	(none)	Wall Mounted
B15.2	B15.2-10	PLAT	♿ ←	(none)	Rail Mounted
B15.2	B15.2-11	PLAT	♿ ←	(none)	Post Mounted
B15.2	B15.2-12	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-13	PLAT	♿ →	(none)	Rail Mounted
B15.2	B15.2-14	PLAT	♿ →	(none)	Post Mounted
B15.2	B15.2-15	PLAT	♿ →	(none)	Wall Mounted
B15.2	B15.2-16	BRIDGE	♿ ↑	(none)	Wall Mounted

NHHS / Berlin
Platform-Bridge Signs
Berlin, CT

B15.2	B15.2-17	BRIDGE		(none)	Wall Mounted
B15.2 Count	17				
B19	B19-01	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-02	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-03	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-04	PLAT	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-05	BRIDGE	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19	B19-06	BRIDGE	AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Wall Mounted
B19 Count	6				
C20	C20-01	PLAT	BERLIN STATION (Grade 2 Braille)	(none	Wall Mounted
C20 Count	1				
D1	D1-01	PLAT		(none)	Rail Mounted
D1	D1-02	PLAT		(none)	Rail Mounted
D1	D1-03	PLAT		(none)	Rail Mounted
D1	D1-04	PLAT		(none)	Rail Mounted
D1	D1-05	PLAT		(none)	Rail Mounted
D1	D1-06	PLAT		(none)	Rail Mounted
D1 Count	6				
D2.1	D2.1-01	PLAT	In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1	D2.1-02	PLAT	In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted

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Platform-Bridge Signs
Berlin, CT

D2.1	D2.1-03	BRIDGE	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1	D2.1-04	BRIDGE	 In Fire Emergency Do Not Use Elevator Use Exit Stairs	(none)	Wall Mounted
D2.1 Count	4				
D2.2	D2.2-01	PLAT	 This is a Smoke-Free Facility	(none)	Wall Mounted
D2.2 Count	1				
D4	D4-01	PLAT	(Exclamation Point Symbol) AUTHORIZED PERSONNEL (Grade 2 Braille)	(none)	Rail Mounted
D4	D4-02	PLAT	(Exclamation Point Symbol) AUTHORIZED PERSONNEL (Grade 2 Braille)		Rail Mounted
D4	D4-03	PLAT	(Exclamation Point Symbol) AUTHORIZED PERSONNEL (Grade 2 Braille)		Rail Mounted
D4 Count	3				
D6	D6-01	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-02	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted

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Platform-Bridge Signs
Berlin, CT

D6	D6-03	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-04	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-05	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6	D6-06	PLAT	WARNING ALL UNATTENDED BAGGAGE WILL BE SEIZED AND SEARCHED	(none)	Rail Mounted
D6 Count	6				

SECTION 116000 - REVENUE COLLECTION SYSTEM

NOTE TO REVIEWER: SECTION WILL BE UPDATED TO REFLECT:

1. THE SOLE SOURCE PROCUREMENT OF THE DIGITAL PAYMENT TECHNOLOGIES LUKE II SYSTEM UNDER FORM 816, AS FOLLOWS:

    a. Form 816, Item No. 0063___A – Revenue Collection System (Site No. 1)
    b. Form 816, Item No. 0063___A – Revenue Collection System (Site No. 3)
    c. Form 816, Item No. 0063___A – Revenue Collection System (Site No. 4)

2. THE INSTALLATION OF THE LUKE II SYSTEM PROCURED UNDER FORM 816, AND THE FURNISHING AND INSTALLATION OF ALL ITEMS INCIDENTAL TO THE RCS, UNDER THE MLSI. THESE ITEMS INCLUDE, BUT ARE NOT LIMITED TO: CONDUIT, WIRING, SPLICE BOXES, RCS SIGNAGE, SIGN POSTS, PAVEMENT MARKINGS FOR STALL NUMBERING, "BACK OFFICE" HARDWARE, CONCRETE, REINFORCING STEEL, CRUSHED STONE, EXCAVATION, BACKFILL, BOLLARDS AND HANDHOLES.

PART I - GENERAL

1.1 DESCRIPTION:

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Under this section the Contractor shall provide all materials, equipment and labor necessary to furnish and install a complete and operational cell-phone based Pay-By-Space (PBS) Revenue Collection System (RCS).

D. RCS shall include PBS meters and parts, footings, anchorages, slabs, lighted enclosures, signing specifically related to the RCS, pavement numerals specifically related to the RCS, enforcement equipment, spare parts, "back office" hardware and software for managing the system and related appurtenances.

E. The system shall be compliant with Payment Card Industry (PCI) Data Security Standards (DSS) Level 1 protocols over a Virtual Private Network (VPN).

F. The system shall include a "back office" hardware and software sufficient to provide operational and administrative capabilities for the RCS.

G. Hardware shall include CPU tower (memory requirements to be specified by RCS equipment manufacturer), 500GB external hard drive, wireless keyboard and mouse, 24" flat panel HD monitor, UPS back-up (30 minutes), color laser printer (11" x 17" capability with copy, scan, fax, print, auto feed) with five spare toner cartridges, internal wireless card, wireless modem.

H. Software shall include the latest Microsoft Windows operating system, the latest Microsoft Office Suite, and management software to prepare standard and custom reports for audit and revenue control purposes.

I. Real-time electronic enforcement system including hand-held WiFi enforcement units/PDAs with built-in digital photo capability and enforcement software for routine and custom enforcement reports.

1.2 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Documentation that the PBS meter manufacturer has:

1. A minimum of five (5) years direct experience under the current business organization in the manufacture of digital electronic PBS meters installed in the United States;
2. Five (5) RCS systems installation of comparable size, two (2) of which shall be in cold climates similar to New England;
3. Owner references for each installation identified in (2) above;
4. An acceptable D&B report;
5. Bank references.

C. Product Data: Provide manufacturer's data including catalog cuts.

D. Shop Drawings: Provide shop drawings for the layout and installation of the RCS equipment, conduit runs, wiring diagrams (point-to-point).

E. Warranties: Special warranties specified in Part 1.5, "Warranty".

F. Provide O&M documentation including requirements of Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - OPERATION AND MAINTENANCE MANUALS.

G. Report validating localized signal strength of WiFi service availability.

H. Report documenting structural integrity and strength of machine foundation assembly.

1.3 CLOSEOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE:

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Conduct a pre-installation meeting at the project site in accordance with the requirements of Form 816 Article 1.20-1.05.24 subsection 2.

C. Provide an on-site technician during RCS equipment installation, RCS start-up to oversee and certify that installation is in compliance with manufacturer's specifications. The technician shall have a minimum of two (2) years experience in the installation, operation, repair and maintenance of the specific equipment supplied under this specification.

D. Provide two (2) "greeters" for a period of one (1) week from the date the system is accepted and placed in operation to assist customers in the proper operation of the equipment. "Greeters" shall be thoroughly familiar with the operation and trouble shooting of the equipment.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.6 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard but in no case less than five (5) years from issuance of Certificate of Compliance.

1.7 SPARE PARTS:

A. Furnish, transport and unload spare parts at a location designated by the Owner as described below.

B. All spare parts shall be packaged in protective covering for storage and clearly identified with labels describing contents.
Spare Parts:

a. Spare vaults: One per each PBS meter.
b. Batteries: Provide one (1) per each PBS meter.
c. Miscellaneous spare parts: Provide assorted spare parts in accordance with PBS equipment manufacturer's documented recommendations for routine maintenance and repair.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 REVENUE COLLECTION SYSTEM:

A. Revenue Collection System (RCS) shall include furnishing and installing operational ADA-compliant cell-phone communications based PBS meters and parts, footings, anchorages, conduits, hand-holes, conductors, drag lines, grounding, WiFi antennas and related equipment, slabs, lighted enclosures, signing specifically related to the RCS, pavement numerals specifically related to the RCS, conduit (buried and surface mounted), enforcement equipment, spare parts, "back office" hardware and software for managing the system and related appurtenances.

B. PBS Meters shall conform to the following parameters:

i. Each PBS meter shall be energy efficient and hard-wired with internal environmentally compatible battery back-up in each machine in the event of loss of power. The battery shall be in charge mode while power is supplied to the equipment so that the battery has a full charge in the event of loss of power.
ii. In the event of battery power engagement, an alarm shall be transmitted to multiple location(s) predetermined by the Owner.
iii. In the event of power loss, the PBS meter shall continue to function and accept a minimum of 7,000 transactions at each machine from one full battery charge.

iv. In the event of communications network failure, the PBS meter shall continue to accept credit card transactions on a batch basis.

v. Each PBS meter shall be fully programmable with interactive graphic display capable of controlling 1,000 spaces.

vi. Display panel shall be easy to read under all lighting and temperature conditions. The display shall be a back lit black on a white LCD. A high impact clear and UV-resistant protective covering of at least 5mm thickness shall cover and protect the display panel.

vii. The display shall clearly and legibly indicate, at a minimum, a brief greeting, the stall number for which the customer is purchasing parking, time of transaction, the amount of time purchased, time of expiration and amount paid. The display shall NOT indicate the amount of revenue contained in the integral PBS meter currency vault.

viii. The display will always be on and not timed out so as not to confuse the customer into believing the PBS meter is not functioning.

ix. Operating instructions shall be prominently displayed for ease of use by the customer including alpha-numeric prompts displayed on the interactive graphic display. The display shall be programmable for multiple messages and prompts.

x. Coin slot shall have a protective door that prevents the introduction of slugs or other foreign objects into the coin chute and resists forced entry. When currency is not being introduced into the coin chute the door shall remain in the closed position.

xi. Integral peripherals to be included within the PBS meter include communications modem and credit card acceptor.

xii. Currency collection shall be accommodated by an integral and interchangeable currency vault. The currency vault shall be capable of accommodating a minimum of $500.00 in coins.

xiii. The housing shall have space available for the future installation of a bill acceptor including a “knock out” panel in the face of the machine should the Owner decide to provide bill acceptors at a later date.

xiv. An interface/port for connection shall be provided in the machine for a future installation of a free standing electronic parking space count indicator sign to be located at the portal entrance to the parking structure. Interface shall include conduit runs (with drag line) to a concrete hand hole with frame and grate at the entrance to the parking garage.

xv. The housing shall have space available for the installation of a signal booster for communications service.

PART 3 - EXECUTION

3.1 INSTALLATION:

Installation shall be in accordance with the plans, details and theses specification

3.2 PBS METER INTEGRITY:

A. The PBS meter housing shall be high impact resistant steel. The steel housing shall be of sufficient gauge as to resist repeated blows from a five (5) pound hammer with no significant deformation or other damage to the steel housing other than paint chipping.

B. Repeated blows to the PBS meter display, while seriously damaging its function, shall not compromise the integrity of the currency vault.

C. The coin compartment entry against surrounding housing shall offer additional security features capable of deterring forced entry. High security, keyed-alike, locks shall be utilized.

D. Currency collection shall be via locked vault exchange, whereby collection staff exchanges a full vault for an empty vault. Vault chain of custody data shall be collected automatically at the time of collection by use of a memory chip located in the vault.

E. A GPS "tag" shall be securely attached to the inside of each vault for tracking the vault in the event of loss or theft of the vault.

F. There shall be an internal adjustable vibration alarm that activates an alarm via WiFi to multiple remote location(s) (central office, law enforcement, etc.) as pre-determined by the Owner in the event there is an attempt to forcibly remove the PBS meter from its foundation or compromise the vault. As this is a commuter railroad station, the vibration alarm shall be adjustable to field conditions to prevent false alarms by passing trains.

3.3 PBS METER ANCHORAGE:

A. The PBS meter housing shall be securely attached using high strength anchor bolts grouted into either pre-cast/cast-in-place structural slabs (in structure) or cast into concrete footings (on grade) and capable of withstanding extraordinary impact.

B. Foundation nuts and bolts shall be concealed within the pedestal mounting housing.

C. The anchorage shall be of sufficient strength to resist pulling force of a 4,000 lb. vehicle starting from rest and full acceleration for a distance of 50'.

3.4 ELECTRONIC ENFORCEMENT FUNCTION:

A. The PBS meter shall include a wireless interface with a handheld ticket writing computer/PDA in the field to generate parking tickets efficiently.

B. The meter must transmit the date, time, location, expired space number, and expired meter duration to the handheld, saving time, improving data accuracy, and assisting with any future enquiries or appeals.

C. The handheld shall have the capability to take a digital photograph.

D. The enforcement officer shall be able to electronically query in real-time any PBS meter to determine the individual space status for the entire parking inventory, as well as the amount of time that expired spaces have been unpaid.

E. The enforcement officer's handheld instrument shall be capable of color coding expired (red), near expired (yellow) and paid (green) spaces for rapid, visual representation of the status of the parking inventory at any given time.

3.5 METER MAINTENANCE AND OPERATION:

A. The parking meter shall be able to create and display maintenance codes that identify information about the meter and its location, faults, and any other criteria related to a deficiency. All of this information must be sent wirelessly to a central wireless meter management system and relayed to technicians via cell phone and/or pager.

B. The PBS shall be fully electronic and use no consumables such as tickets or paper receipts and have no printer or paper-cutting device.

C. There shall be a low battery indication to facilitate timely replacement of batteries.

D. The meter shall retain rate structure and all audit information during battery replacement and/or failure.

E. The following meter components shall be easily interchangeable in the field with no specialized tools:

a. Circuit boards
b. Coin path component
c. Locks
d. Keypads
e. Credit card reader

3.6 DIAGNOSTICS/AUDIT:

The unit shall have a built-in diagnostics software that captures and timestamps all operations events (e.g., unit failures resets, low battery, alarms, etc.) as well as all meter operations events for retrieval and analysis.

3.7 COMMUNICATIONS:

A. The meter must support a variety of different communications options to allow the unit to interface with various remote management and servicing applications.

B. Interfaces must include options of: wireless communication with the management system, removable memory, communication with the vault and infrared connections to peripheral devices.

C. The PBS meter shall be capable of accepting a variety of payment options including coins, tokens, credit cards, smart cards and cell phone.

3.8 COIN PATH:

A. Accepted coins shall include dollar coins (Sacagawea and Susan B. Anthony), quarters, dimes and nickels.

B. The coin path shall be open and easily accessible. The coin discriminator shall incorporate no contact points which could be affected by grime and moisture.

C. The chute shall have an anti-backup provision to prevent the retrieval of coins once deposited.

D. Coins passing through the unit shall be deposited directly into a locked cash vault in a separately locked vault area of the unit.

E. The PBS meter must be equipped with a coin return that returns all objects inserted into the meter that are not recognized as valid forms of payment.

F. The coin path shall have the option for a release mechanism that can automatically attempt to dislodge jammed / foreign objects.

G. The PBS meter shall have a cash vault large enough to contain $500 in U.S. quarters.

3.9 CREDIT CARD/ELECTRONIC PAYMENT MEDIUM:

A. The PBS meter must accept credit card payments.

B. The card discriminator shall check, upon card insertion, the validity of the card.

C. The PBS meters and related systems that interface with or utilize credit card information must be compliant with Payment Card Industry Data Security Standards (PCI DSS).

D. The PBS meters shall have the option to be capable of accepting cashless transactions through smart cards.

E. The meter shall have the option to accept cell phone payments.

F. Cell phone payments shall credit the selected space on the machine in the same manner as coins or credit cards.

G. Enforcement officers must be able to enforce meters irrespective of the payment method. "Virtual" or "overlay" payment solutions that do not register at the meter, requiring enforcement officers to query a source external to the meter (such as a remote database or a handheld device), are not acceptable.

3.10 RATE PROGRAMMING:

A. Time and rate structures shall be programmable by both supplier and the City (with necessary software, hardware and training).

B. Operating software should support variable fee structures/rates and parking restrictions. This should include the ability to support different rate structures for each individual parking space regulated by each machine and to accommodate changes in parking restrictions, such as no parking/standing for rush hour, loading taxi stand, etc., during the span of 24 hours of operation.

C. Each meter should automatically change messages and rates displayed whenever a rate change is in effect. Where more than one rate or parking period is utilized on different days of the week or different times of the day, the user interface/display should automatically reflect this change.

D. The meter should inform the motorist during applicable periods that payments are not required. This may include restricted parking periods such as no parking/standing and similar restrictions. Device software should be capable of enabling those who park in one period to extend their stay to the next, if allowed by the parking restrictions.

E. Customers shall be able to pay for any space from any like meter within a group or grouping of meters.

F. Payment on a space number will add time to any existing time, if previously paid, up to the maximum time allowed. Additional payment will not clear any preexisting time on a space.

END OF SECTION 116000

SECTION 142100 - ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes electric traction passenger elevators.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
2. Section 051200 "Structural Steel Framing" for the following:

    a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
    b. Hoist beams.
    c. Structural-steel shapes for subsills.

3. Section 055000 "Metal Fabrications" for the following:

    a. Attachment plates and angle brackets for supporting guide-rail brackets.
    b. Pit ladders.
    c. Cants in hoistways made from steel sheet.

4. Section 282301 “Video Surveillance System” for the in-car security camera.
5. Section 283111 "Digital, Addressable Fire-Alarm System" Fire-Alarm System" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment and for connection to elevator controllers.

1.3 DEFINITIONS

A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoistway entrances, and operation, control, and signal systems.

C. Working Drawings: The Contractor shall submit working drawings which delineate the proposed elevator manufacture's system, the necessary hoist beam and guiderail supports, and which clearly indicate all other necessary dimensions, clearances, and accompanying items.

1. Include plans, elevations, sections, and large-scale details indicating service at each landing, control closet layout, coordination with building structure, relationships with other construction, and locations of equipment.
2. Include large-scale layout of car-control station and standby power operation control panel.
3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.

D. Samples for Initial Selection: For finishes involving color selection.

E. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch- square Samples of sheet materials; and 4-inch lengths of running trim members.

1.5 INFORMATIONAL SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Qualification Data: For Installer.

C. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Manufacturer Certificates: Signed by elevator manufacturer certifying that the hoistways, pits, control closet configurations, layouts and dimensions, electrical service including standby power generator, and all other work related to or adjacent to the elevators as shown on drawings and as described in the specifications are adequate for the elevator system being provided. The Contractor shall not proceed with the associated work until the elevator manufactures certifies in writing that the conditions stated herein are satisfactory.

E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.

C. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

A. The Contractor shall furnish and install all supports, connections and fasteners necessary to install the approved elevator system within the structural steel frame to meet the CT State Elevator Code and the approved elevator manufacturer’s requirements. The Contractor shall submit working drawings which delineate the proposed elevator manufacture’s system, the necessary hoist beam and guiderail supports, and which clearly indicate all other necessary dimensions, clearances, and accompanying items.

B. Coordination of all field dimensions required by the installation is the responsibility of the Contractor. Additionally, the Contractor shall report any clearance or dimensional issues to the Engineer at least 30 days prior to the fabrication and installation of adjacent construction, and to the manufacturing of the elevator system, so as not to delay the work.

C. The Contractor shall coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

D. Coordinate locations and dimensions of other work relating to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 WARRANTY

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
2. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Otis Elevator Co. Gen-2 machine room-less elevator or comparable product by one of the following:

1. KONE Inc.
2. Schindler Elevator Corp.
3. ThyssenKrupp Elevator.

B. Source Limitations: Obtain elevators, including hydraulic passenger elevators specified in another Section, from single manufacturer.

1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.

B. Accessibility Requirements: Comply with Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and with ICC A117.1 and the Connecticut State Building Code.

2.3 ELEVATORS

A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.

B. Elevator Description:
1. Machine Location: Hoistway; no machine room is provided.
2. Rated Load: 3500 lb.
3. Rated Speed: 150 fpm.
4. Operation System: Selective-collective automatic operation.
5. Auxiliary Operations:

a. Standby power operation.
b. Standby-powered lowering.
c. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44.
d. Automatic dispatching of loaded car.
e. Nuisance call cancel.
f. Electronic Brake Release.

6. Car Enclosures:

a. Inside Width: 6’-5 9/16” from side wall to side wall.
b. Inside Depth: 5’-5 9/16” from back wall to front wall (return panels).
c. Inside Height: 93 inches to underside of ceiling.
d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish.
e. Car Fixtures: Satin stainless steel, No. 4 finish.
f. Side Wall Panels: Textured stainless steel.
g. Rear Wall: One-Half Glazed.
h. Reveals: Satin stainless steel, No. 4 finish.
i. Door Faces (Interior): Textured stainless steel.
j. Door Sills: Nickel silver, polished.
k. Ceiling: Satin stainless steel, No. 4 finish or approved equal.
l. Handrails: 1-1/2 inches round satin stainless steel, No. 4 finish, at sides and rear of car.
m. Floor: Rubber Tile.

7. Hoistway Entrances:

a. Width: 42 inches.
b. Height: 84 inches.
c. Type: Single-speed side sliding.
d. Frames: Satin stainless steel, No. 4 finish.
e. Doors: Textured stainless steel.
f. Sills: Nickel silver, polished, heat traced.

8. Hall Fixtures: Satin stainless steel, No. 4 finish.

9. Additional Requirements:

a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
b. Provide hooks for protective pads in all cars and complete set(s) of full-height protective pads.
c. Contractor shall furnish and install conduit from the elevator control rooms to the top of elevator cabs for the in-cab security cameras.
d. Contractor shall furnish and install elevator control closet thermostatically-controlled heaters in order to maintain adequate room temperature as required by elevator manufacturer.
e. Contractor shall furnish and install elevator control closet thermostatically-controlled ventilation fans in order to maintain adequate room temperature as required by elevator manufacturer.
f. Contractor shall furnish and install properly-sloped cants on all horizontal surfaces as required by the State Elevator Code.

2.4 TRACTION SYSTEMS

A. Elevator Machines: Variable-voltage, variable-frequency, ac-type hoisting machines or variable-voltage dc-type hoisting machines and solid-state power converters.

1. Provide regenerative or nonregenerative system.
2. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
3. Provide means for absorbing regenerated power when elevator system is operating on standby power.
4. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

B. Fluid for Hydraulic Buffers: If using hydraulic buffers, use only fire-resistant fluid.

C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.

D. Machine Beams: Provide framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 055000 "Metal Fabrications" for materials and fabrication.

E. Car Frame and Platform: Bolted- or welded-steel units.

F. Guides: Roller guides or polymer-coated, non-lubricated sliding guides. Provide guides at top and bottom of car and counterweight frames.

2.5 OPERATION SYSTEMS

A. General: Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:

1. Single-Car Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby. Manual operation causes automatic operation to cease.
2. Single-Car Battery-Powered Lowering: If power fails and it is lowered to the bottom floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
3. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
4. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls can be adjusted.

C. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

1. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at hall push-button stations. Key is removable in either position.

2. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes car to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

2.6 DOOR REOPENING DEVICES

A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.

B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

A. General: Provide steel-framed car enclosures with nonremovable wall panels, with removable car roof, access doors, power door operators, and ventilation.

1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.

B. Materials and Finishes: Manufacturer's standards, but not less than the following:

1. Subfloor: Exterior, underlayment grade plywood, not less than 5/8-inch nominal thickness.

2. Floor Finish: Rubber tile; color to be chosen from manufacturer’s full line.
3. Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
4. Glass One-Half of Rear Wall of car (across from controls side of car): Laminated glass ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Provide safety glazing labeling. Markings as specified in ANSI Z97.1, shall be present on each separate piece of glass and shall remain visible after installation.
5. Fabricate car with recesses and cutouts for signal equipment.
6. Fabricate car door frame integrally with front wall of car.
7. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet or by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
8. Sight Guards: Provide sight guards on car doors.
9. Sills: Extruded metal, with grooved surface, 1/4 inch thick.
10. Metal Ceiling: Flush panels, with minimum six low-voltage downlights in each panel.
11. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

2.8 HOISTWAY ENTRANCES

A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.

1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.

B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to UL 10B.

1. Fire-Protection Rating: 1-1/2 hours.

C. Materials and Fabrication: Manufacturer's standards, but not less than the following:

1. Enameled-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected by Architect from manufacturer's full range.
2. Stainless-Steel Frames: Formed from stainless-steel sheet.
3. Star of Life Symbol: Identify emergency elevators with star of life symbol, not less than 3 inches high, on both inside surfaces of hoistway door frames.
4. Stainless-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from stainless-steel sheet or by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
5. Sight Guards: Provide sight guards on doors matching door edges.
6. Sills: Extruded metal, with grooved surface, 1/4 inch thick.

7. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

2.9 SIGNAL EQUIPMENT

A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life lamps and acrylic or other permanent, non-yellowing translucent plastic diffusers or LEDs.

B. General: Provide signal equipment designed for destination-based system. Fabricate lighted elements with long-life lamps and acrylic or other permanent, nonyellowing translucent plastic diffusers or LEDs.

C. Car-Control Stations: Provide manufacturer's standard recessed or semirecessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.

1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

D. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.

E. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet in each car and required conductors in traveling cable for firefighters' two-way telephone communication service.

F. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

G. Hall Push-Button Stations: Provide one hall push-button station at each landing.

1. Provide manufacturer's standard wall-mounted units.
2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
3. Equip units with buttons or touch screen for calling elevator and for indicating direction of travel or destination as required by system. Provide a signaling system to verify floor selection, where destination registration is required, and to direct passengers to appropriate car.

H. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified.

1. Possibly insert a provision for either an "In Use" signal or a digital display of car position for single elevators.

I. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:

1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.

J. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.

1. At manufacturer's option, audible signals may be placed on cars.

K. Hall Position Indicators: Provide illuminated, digital-display-type position indicators, located above each hoistway entrance at ground floor. Provide units with flat faceplate for mounting and with body of unit recessed in wall.

1. Integrate ground-floor hall lanterns with hall position indicators.

L. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.

M. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.

N. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

A. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.

B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.

C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

E. Textured Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 with embossed texture rolled into exposed surface.
1. Metal surface is satin polished after texturing.

F. Stainless-Steel Bars: ASTM A 276, Type 304.

G. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.

H. Aluminum Extrusions: ASTM B 221, Alloy 6063.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions.

B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.

C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.

D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

F. Leveling Tolerance: 1/8 inch, up or down, regardless of load and travel direction.

G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

H. Locate hall signal equipment for elevators as follows unless otherwise indicated:
   1. Place hall lanterns either above or beside each hoistway entrance.
   2. Mount hall lanterns at a minimum of 72 inches above finished floor.

I. Test and adjust elevator seismic settings during normal railroad operations to ensure that elevators function without failure.

3.3 FIELD QUALITY CONTROL

A. Contractor shall advise Engineer at least 30 days advance of final elevator inspection to procure telephone service.

B. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.

C. Operating Test: Load each elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.

D. Advise Owner and Engineer in advance of dates and times that inspections are to be performed on elevators by the State Elevator Inspector.

3.4 PROTECTION

A. Temporary Use: Comply with the following requirements for elevator used for construction purposes:

1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
2. Provide strippable protective film on entrance and car doors and frames.
3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
5. Do not load elevators beyond their rated weight capacity.
6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).

B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.6 MAINTENANCE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of elevator Installer/maintainer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance during normal working hours.
2. Perform emergency callback service during normal working hours with response time of two hours or less.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.

END OF SECTION 142100

SECTION 220000 - PLUMBING

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SECTION 220000 - PLUMBING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.02 DESCRIPTION OF WORK

A. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

B. The work under this Contract shall include all labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings, but which are usually provided or are essential for proper installation and operation, of all systems as indicated on the drawings and specified herein.

C. Coordinate work with that of all other Trades affecting or affected by the work of this Section. Cooperate with such Trades to assure the steady progress of all work under the Contract.

D. The specifications and drawings describe the minimum requirements that must be met by the Plumbing Subcontractor for the installation of all work as shown on the drawings and as specified here-in-under. The following major items of work are included under Section 220000:

1. Soil Waste and Vent Piping Systems

2. Domestic Cold Water Piping Systems

3. Clear water waste piping systems

4. Storm conductor piping systems

5. Indirect waste piping system

6. Insulation

7. Plumbing Fixtures and Trim

8. Drains:

    a. Floor Drains

    b. Area Drains

    c. Trench Drains

9. Instructions

10. Valves

11. Seismic Bracing Design, Installation and Certification

12. Core Drilling 12” diameter and smaller

13. Furnish and Installation of Firestopping and Smokestopping

14. Furnishing of Access Panels

15. Verification Testing

16. Assistance to Commissioning Agent

17. Record Drawings/As-Built Drawings

18. Operation and Maintenance Manuals

19. Building Automation System

20. Testing, Disinfection and Certification

21. Roughing and final connections to equipment furnished under other sections (kitchen, laboratory and casework)

22. Hangers, sleeves and appurtenances

23. Cleaning and adjusting

24. Staging, scaffolding and rigging

25. Phasing

26. Sump pump systems

27. Permits and fees

28. Wall hydrants and hose bibs

29. Natural gas piping systems

30. Commissioning

31. Modifications to existing piping system

32. Instructing Owner's Personnel

33. Assisting the Advanced Commissioning Agent

34. Subcontractor certificate of completion

1.03 RELATED WORK

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Furnish the following materials to be installed under other Divisions and Sections as listed.

1. Installation of access panels furnished under this Section shall be by the Trades as designated by the Construction Manager/General Contractor.

C. The following work is not included in this section and is to be performed under other sections of the specifications:

1. Cutting and patching.

2. Housekeeping pads

3. Flashing of all pipe penetrations

4. Finish painting

5. Heating, ventilation and air conditioning work

6. Electrical power wiring

7. Temporary light, power, water, heat, and sanitary facilities for use during construction and testing.

8. Fire Protection work

9. Fire alarm work

1.04 UTILITY COMPANY BACK-CHARGES

A. The Plumbing Subcontractor shall carry in the bid price all Utility Company back-charges for all materials furnished and all work performed by them in conjunction with this Contract and pay same to the respective agency upon demand. The Plumbing Subcontractor shall not be entitled to additional compensation after the submittal of his bid price should he fail, for any reason, to obtain the total back-charges to be incurred by the local Utility company or municipal agency. When a cost is not available, this Plumbing Subcontractor shall carry a sum of $10,000.00.

B. The balance of the allowance for the utility backcharges not utilized during the project construction shall be returned to the owner in their entirety.

1.05 PERMITS, FEES AND TAXES

A. Plumbing Subcontractor for the work in his scope of work shall give all necessary notices, obtain all permits, pay all governmental taxes, fees and other costs in connection with his work; file for necessary approvals with the jurisdiction under which the work is to be performed. Plumbing Subcontractor shall obtain all required Certificates of Inspection for his respective work and deliver same to the Architect before request for acceptance of his portion of work is made and before final payment.

1.06 REFERENCES

A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations, latest editions.

B. In case of difference between Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the Plumbing Subcontractor shall promptly notify the Architect in writing of any such difference.

C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern.

D. Should the Plumbing Subcontractor perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, he shall bear all costs arising in correcting the deficiencies, as approved by the Architect/Owner.

E. Applicable Codes and Standards shall include all State Laws, Local Ordinances, Utility Company Regulations, and the applicable requirements of the latest adopted edition of the following Codes and Standards, without limiting the number, as follows:

1. NFPA 70: National Electrical Code
2. NFPA 54: National Fuel Gas Code
3. NFPA 101: Life Safety Code
4. ASSE: American Society of Sanitary Engineers
5. EJMA (STDS) – Standards; Expansion Joint Manufacturers Association; 1993.
6. Occupational Safety and Health Standards
7. Environmental Protection Agency
8. National Fire Protection Association
9. Connecticut Department of Environmental Protection
10. International Building Code (IBC)
11. International Plumbing Code
12. Connecticut Building Code with all the applicable addendums
13. Connecticut Plumbing Code with all the applicable addendums
14. Connecticut State Inspectional Department
15. All other standards applicable to state of Connecticut.

F. In these specifications, references made to the following Industry Standards and Code Bodies are intended to indicate the latest volume or publication of the Standard. All equipment, materials and details of installation shall comply with the requirements and latest revisions of the following Bodies, as applicable:

1.	ANSI:	American National Standards Institute
2.	ASTM:	American Society of Testing Materials
3.	FM:	Factory Mutual
4.	ASSE:	American Society of Sanitary Engineers
5.	CS:	Commercial Standards, U.S. Department of Commerce
6.	MSS:	Manufacturer's Standardization Society of the Valve and Fittings Industry
7.	ASME:	American Society of Mechanical Engineering
8.	AWS:	American Welding Society
9.	NEMA:	National Electrical Manufacturers Association
10.	UL:	Underwriters' Laboratories

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. The manufacturers listed within these specifications have been pre-selected for use on this project. Where equipment of a substitute manufacturer differs from that specified require different arrangements or connections from those shown, it shall be the responsibility of the Subcontractor responsible for the substitution to modify the installation of the equipment/system to operate properly and in harmony with the original intent of the drawings and specifications. When directed by the Architect, the Plumbing Subcontractor shall submit drawings showing the proposed, substitute installation. If the proposed installation is accepted, the Plumbing Subcontractor shall make all necessary changes in all affected related work provided under his and other Sections including location of roughing in connections by other Trades, conduit, supports, etc. All changes shall be made at no increase in the Contract amount or additional cost to the Owner. The General Contractor shall be responsible to assure that the Subcontractor

responsible for the substitution bears the cost arising to all other Trades as a result of the substitution.

C. All substitutions shall be accompanied by a completed Substitution Request Cover Sheet contained within this section.

D. Plumbing Subcontractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner.

E. Unless specifically indicated otherwise, all equipment and materials required for installation under these specifications shall be new, unused and without blemish or defect. Equipment and materials shall be products which will meet with the acceptance of the Authorities having jurisdiction over the work and as specified hereinbefore. Where such acceptance is contingent upon having the products listed and/or labeled by FM or UL or another testing laboratory, the products shall be so listed and/or labeled. Where no specific indication as to the type or quality of material or equipment is indicated, a first class standard article shall be provided.

F. The following substitution request sheet shall be copied on to the Contractor's letterhead, filled out, signed and sealed by an Authorized Officer of the Corporation then submitted to the Architect to be approved prior to any substitutions being considered, including all "equals" by manufacturers' not listed in the specifications.

SUBSTITUTION REQUEST COVER SHEET

This cover sheet is required for all proposed substitutions including "or equal"s.

Contractor: _____

Subcontractor: _____

This Request Reference Number _____

Substitution Summary: _____

_____

Specification Section and Paragraph Number: _____

Contract Drawing and Detail Reference: _____

Date of This Request: _____

This Request Prepared By: _____

Conditions: Indicate all conditions that apply to this proposed substitution:

[ ] Substitution required because specified item is no longer available.

[ ] Substitution required because Contractor believes specified item is incorrect, inappropriate, or incompatible.

[ ] Substitution recommended because it offers the Owner substantial advantage in:

- [ ] Quality
- [ ] Time
- [ ] Cost
- [ ] This is an "or equal".

Evidence: Indicate evidence attached:

[ ] Tabulated side by side comparison of specified item and proposed substitution directly comparing each feature, characteristic, and performance.

[ ] Manufacturer's product data for both specified item and proposed substitution. Origin of all information included on tabulated side by side comparison is highlighted.

[ ] Details showing how the proposed substitution interfaces with adjacent work.

[ ] Certification that warranty, if any required, will be provided as required.

[ ] Certification that this proposed substitution is coordinated with all related and adjacent work.

[ ] Complete cost change information.

[ ] Higher cost to Owner as stated in cost change information

[ ] No change in cost to Owner

[ ] Lower cost to Owner, credit to Owner as stated in cost change information

Deviations from Contract Documents: Itemize all deviations from Contract Documents if this proposed substitution is approved.

The undersigned attests that the undersigned has carefully examined this entire submission and that the requirements of the Contract Documents have been met.

Should this alternate material or equipment fail to meet the expectations of the owner within the mandated design liability period, this contractor shall replace the material and or equipment with the original specified items at no additional cost to the owner. This Subcontractor shall be responsible for all collateral impacts to the project for replacement of such deviations and substitutions.

Firm: _____ (seal)

By: _____ _____
Signature date

_____ _____
Printed or Typed Name Title

1.08 VALUE ENGINEERING

A. When equipment and/or materials are purchased from a manufacturer other than those specified, or this Subcontractor deviates from the engineers design under a Value Engineering Proposal or Substitution, the subcontractor shall provide a written guarantee that all systems shall perform equal to or better than the original design for the work. This Subcontractor shall be responsible for all collateral impacts to the project for replacement of such deviations and substitutions.

B. Refer to Section 01 25 00 of Division 1 – Substitution Procedures for the requirements of this Section.

C. The manufacturers listed within this specification have been preselected for use on this project. Where equipment of a substitute manufacturer differs from that specified require different arrangements or connections from those shown, it shall be the responsibility of the Subcontractor responsible for the substitution to modify the installation of the equipment/system to operate properly and in harmony with the original intent of the drawings and specifications. Should the Plumbing Subcontractor wish to propose a substitution during the bid period, such request shall be made in writing to the Architect, no less than seven (7) working days, prior to bid date. If substitutions are deemed acceptable, such items shall be issued on as an Addendum by the contractor, prior to bid due date The above requirement is mandatory.

D. All substitutions shall be accompanied by a completed Substitution Request Cover Sheet contained within this section of the specifications.

E. Should this alternate material or equipment fail to meet the expectations of the owner within the guarantee period, this contractor shall replace the material and or equipment with the original specified items at no additional cost to the owner. This Subcontractor shall be responsible for all collateral impacts to the project for replacement of such deviations and substitutions.

1.09 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information act.

B. All warranties shall begin on the Date of Substantial Completion of the entire project or the Owner's acceptance of the workmanship and/or material covered by the warranty, whichever is later. The warranty coverage shall continue for the specified period. Refer to individual specification sections for warranty period. If no specific warranty period is specified, the warranty shall extend for a minimum of 365 days.

C. Manufacturers shall provide their standard warranties for work under the Plumbing Trades. However, such warranties shall be in addition to, and not in lieu of, all other liabilities which the manufacturer and Plumbing Subcontractor may have by law or by other provisions of the Contract Documents.

D. All materials, items of equipment and workmanship furnished under the Plumbing Section shall carry the standard warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Plumbing Subcontractor for the work under his Contract, including all other damage done to areas, materials and other systems resulting from this failure.

E. The Plumbing Subcontractor shall warranty that all elements of the systems which are to be provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

F. Upon receipt of notice from the Owner or Architect of failure of any part of the systems or equipment during the warranty period, the affected part or parts shall be replaced by the Plumbing Subcontractor for his work or any other work affected by the failure(s).

G. Plumbing Subcontractor shall furnish, before the final payment is made, a written warranty covering the above requirements in accordance with the General Requirements.

H. Upon final acceptance of the project by the Owner, the (1) year guarantee period of all equipment and materials will be initiated. During this period, the Contractor shall make a minimum of (2) visits to the site ([6] months after acceptance and immediately prior to the end of the guarantee period). These visits shall be performed in the presence of the Owner's representative. During each visit, the Contractor shall thoroughly check all equipment for proper operation and respond to any list of deficiencies prepared by the Owner. Formal reports shall be generated and forwarded to the Department of Physical Plant and Architect's Office describing the systems inspected, date of inspection and status of equipment.

1.10 DEFINITIONS

A. Words in the singular shall also mean and include the plural, wherever the context so indicates, and words in the plural shall mean the singular, wherever the context so indicates.

B. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.

C. Wherever the term "provide" is used in the specifications it will mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.

D. Wherever the term "material" is used in the specifications it will mean any "product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.

E. The terms "approved", or "approval" shall mean the written approval of the Architect. Where indicated in the product section of the specifications, “Approved Equal” shall mean the proposed substitute product must be approved by the Owner, Architect and Engineer in writing prior to acceptance on the project for submission. Basis of approval of a substitute product submitted for “Approved Equal” shall be at the sole discretion of the Owner, Architect and Engineer.

F. The term "Contract Documents" shall mean the entire set of Drawings and Specifications as listed in the Table of Contents of the General Conditions including all bound and unbound material and all items officially issued to date such as addenda, bulletins, job modifications, etc.

G. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.

H. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed", and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect; the terms "approved", "acceptable", "satisfactory", and similar words shall mean approved by, acceptable or satisfactory to the Architect; and, the terms "necessary", "reasonable", "proper", "correct", and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.

I. "Accessible" indicates ease of access with or without the use of ladders and without requiring extensive removal of other equipment, such as ductwork, piping, etc. to gain access. "Accessible ceiling" indicates acoustic tile type hung ceilings. Concealed spline or sheetrock ceilings with access panels shall not be considered accessible ceilings.

J. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.

K. "Exposed" means not installed underground or "concealed" as defined above.

L. "Plumbing Subcontractor" or “Plumbing Contractor” refers to the Subcontractor or Contractor responsible for furnishing and installation of all work indicated on the Plumbing drawings and in the Plumbing specifications.

M. "Architect" shall refer to the Architect "[Insert the Architectural Firm]”

N. "Owner" shall refer to the Owner "[Insert name of Owner]" or their designated representative.

O. "Other Work Contractor" (O.W.C.) refers to the Contractor(s), or Subcontractor(s) performing work under other Sections of the Contract Documents.

P. “O.F.C.I” means ”Owner Furnished Contractor Installed”.

Q. “O.F.O.I” means “Owner Furnished Owner Installed”.

R. Engineer shall refer to "Robert W. Sullivan Engineers, Inc. (RWS)".

1.11 THE SUBCONTRACTOR

A. The Plumbing Subcontractor shall visit the site of the proposed new facility and base his bids from his own site examinations and estimates. The Plumbing Subcontractor shall not hold the Architect, Engineer, Owner or their agents or employees responsible for, or bound by, any schedule, estimate or of any plan thereof. The Plumbing Subcontractor shall study the Contract Documents included under this Contract to determine exactly the extent of work provided under this Contract, as well as to ascertain the difficulty to be encountered in performing the work, in installing new equipment and systems and coordinating the work with the other Trades and existing building conditions.

B. The Plumbing Subcontractor shall faithfully execute his work according to the terms and conditions of the Contract and specifications, and shall take all responsibility for and bear all losses resulting to him in the execution of his work.

C. The Plumbing Subcontractor shall be responsible for the location and performance of work provided under his Contract as indicated on the Contract Documents. All parties employed directly or indirectly by the Plumbing Subcontractor shall perform their work according to all the conditions as set forth in these specifications.

D. The Plumbing Subcontractor shall furnish all materials and do all work in accordance with these specifications, and any supplementary documents provided by the Architect. The work shall include everything shown on the drawings and/or required by the specifications as interpreted by the Architect, regardless of where such information is indicated in the Contract Documents (Architectural, HVAC, Plumbing, Fire Protection, etc.). Unless specifically indicated otherwise, all work and materials furnished and installed shall be new, unused and of the best quality and workmanship. The Plumbing Subcontractor shall cooperate with the Architect so that no error or discrepancy in the Contract Documents shall cause defective materials to be used or poor workmanship to be performed.

1.12 COORDINATION OF WORK

A. The Plumbing Subcontractor shall compare his drawings and specifications with those of other Trades as well as the Architectural drawings and specifications, and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the plumbing work.

B. Coordinate work with that of all other Trades affecting or affected by the work of this Section. Cooperate with such Trades to assure the steady progress of all work under the Contract.

C. All work shall be installed in cooperation with other Trades installing interrelated work. Before installation, Plumbing Subcontractor shall make proper provisions to avoid interferences in a manner approved by the Architect. All changes required in the work of the Plumbing Subcontractor or that of any other trade caused by the Plumbing Subcontractor's neglect, shall be made by him at his own expense, and to the Architect's satisfaction.

D. The Plumbing Subcontractor shall include in his bid sufficient dollar amounts to coordinate the work of this Contract. This project MAY require additional time to coordinate all Trades and allow implementation of the Owner’s Standards and maintenance serviceability requirements. This requirement shall include, but not be limited to, producing the coordination drawings, as many times and as many drawings as required, to ensure serviceability of equipment, as approved by the Architect.

E. Locations of pipes and equipment, etc. shall be adjusted to accommodate the work with interferences anticipated and encountered. The Plumbing Subcontractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings shall be completed to verify dimensions and characteristics of the various systems installations.

F. Lines which pitch shall have the right-of-way over those which do not pitch. For example, gravity drainage piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.

G. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. The Plumbing Subcontractor shall provide offsets and materials and labor required to achieve these offsets etc. as required for his work to effect these offsets, transitions and changes in direction.

H. All work shall be installed in a way to permit removal (without damage to other parts) of coils, filters, control appurtenances, belts and belt guards, drives, sheaves and all other system components provided under this Contract requiring periodic replacement or maintenance. All piping and appurtenances shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles. All work shall be done to allow easy access for maintaining equipment. The Owner and Engineer will require proof via the preparation of large scale sections and part plans that all components are accessible after the work is completed. Any items in the field discovered to be in non-compliance shall be removed and relocated, as required, and as directed by the Architect and at no cost to the Owner.

I. The Contract Drawings are diagrammatic only intending to show general runs and locations of piping, equipment, etc. and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.

J. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, alarm points, etc., exist, such conflicts shall be reported to the Architect during bidding and prior to signing of the Contract. If such action is not taken, the Plumbing Subcontractor shall furnish such items as part of his work as necessary, for complete and operable systems and equipment, as determined by the Architect.

K. Where drawing details, plans, specification requirements and/or scheduled equipment capacities are in conflict and where piping or equipment are shown to be different (including pipe sizes) between plans and/or between plans and details or specifications, the most stringent requirement will be included in the Contract. Plumbing systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any

portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.

L. Final location of all plumbing fixtures, access panels, cleanouts, wall layouts, trench and floor drains, etc., shall be coordinated with the Architectural reflected ceiling plans, architectural elevations, and/or other Architectural details, as applicable and shall not be scaled from locations indicated on the Plumbing drawings. Obtain approval of locations of all items from Architect in the field.

M. The Plumbing Subcontractor shall coordinate his work with other Trades' work so that all equipment and systems can be easily, safety and properly serviced and maintained. It is imperative that service personnel can safely access all equipment.

1.13 GIVING INFORMATION

A. Plumbing Subcontractor shall keep himself fully informed as to the shape, size and position of all openings required for his equipment and shall give information to the General Contractor and other Subcontractors sufficiently in advance of the work so that all openings may be built in advance.

1.14 EQUIPMENT AND MATERIALS

A. All Equipment of one type (such as valves, pumps, water heaters, drainage specialties, interceptors/traps, etc.,) shall be the product of one manufacturer, unless noted otherwise in this specification.

B. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as switches, controls, etc., shall be stored in dry, heated spaces.

C. Equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect. Damage or defects that develop before acceptance of the work shall be made good at the Plumbing Subcontractor's expense.

D. The Plumbing Subcontractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his respective Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.

E. Manufacturers' directions shall be followed completely in the delivery, storage, protection and installation. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions. Obtain the Architect's written instructions before proceeding with the work. Should Plumbing Subcontractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.

F. Equipment pre-purchased by the General Contractor on behalf of the Owner or by the Owner himself, if assigned to the Plumbing Subcontractor, shall be received, installed, tested, etc., as if the equipment was purchased by the Plumbing Subcontractor. All guarantees, service contracts, etc., shall be the same as for all other equipment provided under this Contract.

G. Refer to Section 01 25 00 of Division 1 – Substitution Procedures for the requirements of this Section.

H. The manufacturers listed within this specification have been preselected for use on this project. Where equipment of a substitute manufacturer differs from that specified require different arrangements or connections from those shown, it shall be the responsibility of the Subcontractor responsible for the substitution to modify the installation of the equipment/system to operate properly and in harmony with the original intent of the drawings and specifications. Should the Plumbing Subcontractor wish to propose a substitution during the bid period, such request shall be made in writing to the Architect, no less than seven (7) working days, prior to bid date. If substitutions are deemed acceptable, such items shall be issued on as an Addendum by the contractor, prior to bid due date The above requirement is mandatory.

I. All substitutions shall be accompanied by a completed Substitution Request Cover Sheet contained within this section of the specifications.

J. The Plumbing Subcontractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner.

K. All equipment and materials required for installation under these specifications shall be new and without blemish or defect. Equipment and materials shall be products which will meet with the acceptance of the Authorities having jurisdiction over the work and as specified hereinbefore. Where such acceptance is contingent upon having the products listed or labeled by FM, UL or other testing laboratories, the products shall be so listed or labeled. Where no specific indication as to the type or quality of material or equipment is indicated, a first class standard article shall be provided.

1.15 USE OF PREMISES

A. The Plumbing Subcontractor shall confine all apparatus, storage of materials and construction to the limits as directed by the Architect and he shall not encumber the premises with his materials. The Plumbing Subcontractor shall be held responsible for repairs, patching, or cleaning arising from any unauthorized use of premises.

B. In storing materials within areas (structure or ground), or when used as a shop, the Plumbing Subcontractor shall consult with the Construction Manager and shall restrict his storage to space designated for such purposes. The Plumbing Subcontractor will be held responsible for repairs, loss, patching or cleaning arising from any unauthorized use of the premises.

C. Notwithstanding any approvals or instructions which must be obtained by the Plumbing Subcontractor from the Architect in connection with the use of the premises, the responsibility for the safe working conditions at the site shall remain that of the Plumbing Subcontractor. The Architect, Engineer or Owner shall not be deemed to have any responsibility or liability in connection with safe working conditions at the site.

1.16 PROTECTION

A. Materials, such as valves, pipes, fittings, plumbing fixtures, drains, etc., shall be properly protected during construction and all pipe openings shall be temporarily closed so as to prevent obstruction and damage. Post notice prohibiting the use of all systems provided under the Plumbing Contract, prior to completion of work and acceptance of all systems by the Owner except as otherwise instructed by Architect. Take precautions to protect all materials furnished from damage and theft.

B. The Plumbing Subcontractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or electrical systems provided under his Contract.

1.17 DAMAGE TO OTHER WORK

A. The Plumbing Subcontractor shall be held responsible and shall pay for all damages caused by his work to the building structures, equipment, conduits, systems, etc., and all work and finishes installed under this Contract. Repair of such damage shall be done by the General Contractor at the expense of the Plumbing Subcontractor, to the Architect's satisfaction.

1.18 CORRECTION OF WORK

A. The Plumbing Subcontractor shall promptly correct all work provided under his Contract and rejected by the Architect as defective or as failing to conform to the Contract Documents, whether observed before or after completion of work, and whether or not fabricated, installed or completed.

1.19 EXTRA WORK

A. No claim for extra work will be allowed unless it is authorized by the Architect in writing before commencement of the extra said work.

1.20 TOUCH-UP PAINTING

A. All equipment and systems shall be thoroughly cleaned of rust, splatters and other foreign matter or discoloration leaving every part of all systems in an acceptable prime condition. The Plumbing Subcontractor, for the work under his Contract, shall refinish and restore to the original condition all equipment which have sustained damage to the manufacturer's prime and finish coats of paint and/or enamel during the course of construction, regardless of the source of damage.

1.21 TRAINING AND OPERATION AND MAINTENANCE MANUALS

A. The Plumbing Subcontractor shall thoroughly instruct the Owner, to the complete satisfaction of the Architect and Engineer, in the proper operation of all systems and equipment provided by him The Plumbing Subcontractor shall make arrangements, via the Architect, as to whom the instructions are to be given in the operation of the basic and auxiliary systems and the period of time in which they are to be given. The Architect shall be completely satisfied that the Owner has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by the Plumbing Subcontractor to the Owner's representative, then the Plumbing Subcontractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this specification has been complied with. No extra compensation for such instruction will be allowed.

B. The plumbing subcontractor shall provide to the owner’s designated personnel instructions and training on the operation and maintenance of all of the plumbing systems and equipment.

The instructions shall contain information deemed necessary by the Architect and shall include, but not be limited, to the following:

a. Explanation of manual and its use.

b. Summary description of the plumbing systems.

c. Purpose of systems.

C. Plumbing Subcontractor shall submit to the Architect for approval typed O & M manual sets in the quantity required in Division 1 (see General Conditions and Division 1, for the required member of copies bound neatly in 3-ring binders. Binders shall contain all instructions for the installation, operation, emergency operation, start-up, care and maintenance of all equipment and systems (including instructions for the ordering and stocking of spare parts for all equipment installed under this Contract). The lists shall include part numbers and suggested supplier. Each set shall also include an itemized list of component parts that should be kept on hand and where such parts can be purchased.

D. O & M manuals shall contain information indicating possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section shall be clearly divided from the other sections. A sub-index for each section shall also be provided. The methodology of setting-up the manuals shall be submitted to the Architect and Owner for review prior to final submission of manuals.

E. The O & M manuals shall contain instructions including information deemed necessary by the Architect and shall also include, but not limited to, the following:

1. Introduction

   a. Explanation of Manual and its use.

   b. Summary description of each Plumbing system.

   c. Purpose of each system.

2. System

   a. Detailed description of each system.

   b. Illustrations, schematics, block diagrams, catalog cuts, and other exhibits.

3. Operations

   a. Complete detailed, walk-through, with step-by-step, sequential description of all phases of operation for all portions of the systems, including start-up, shutdown, testing and adjusting. Include all posted instruction charts.

4. Maintenance

a. Parts list and part numbers.

b. Maintenance, and replacement charts and Plumbing Subcontractor's recommendations for preventive maintenance.

c. Troubleshooting charts for systems and components.

d. Instructions for testing each type of part.

e. Recommended list of on-hand spare parts.

f. General or miscellaneous maintenance notes.

g. Provide an estimate of man hours and material costs to perform scheduled preventative maintenance.

5. Manufacturer's Literature

a. Complete listing for all parts with names, addresses and telephone numbers.

b. Care and operation.

c. FINAL APPROVED SHOP DRAWINGS FOR ALL EQUIPMENT, including all and only pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.

d. Internal wiring diagrams and engineering data sheets for all items and/or equipment to be furnished.

e. Guarantee and warranty data.

1.22 START-UP AND COMMISSIONING OF SYSTEMS

A. The Plumbing Contractor, as applicable, shall commission and set in operating condition all major equipment and systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. In no case will major systems and equipment be commissioned by any of the Contractor's forces alone, without the assistance or presence of the equipment manufacturers.

B. A written report shall be issued by the particular equipment manufacturer and the Plumbing Contractor summarizing the results of the commissioning and

performance of each system for the Architect's record. No additional compensation will be allowed for any Contractor for such services.

C. Refer to Division 1 -General Requirements for the requirements of this Section.

D. Instruct to the Owner's satisfaction such persons as the Owner designated, in the proper operation and maintenance of all systems and equipment and their parts.

E. Furnish operating and maintenance manuals prior to instructions and forward same to the Architect for transmittal to the Owner.

F. This Contractor shall give detailed instructions for a period of not less than 10 days, straight time, to the responsible personnel designated by the Owner in the operation and maintenance of all systems and equipment furnished under this Contract. A letter with five copies containing the name of the person or persons to whom the instructions were given and the dates of instruction period shall be submitted to the Architect/Engineer. Start-up and testing of all equipment supplied by this Contractor shall be performed by authorized factory representatives supplying equipment. Notification of this work must be given to the Owner.

G. This Contractor shall submit to the Architect/Engineer for approval the required # of sets of operating and instruction manuals, spare parts lists, drawings, manufacturer's bulletins and other pertinent data on all equipment furnished under this Contract. Each set shall be enclosed in a suitable hard cover binder. This information must be submitted to the Owner when systems are approximately 90% complete to allow for proper review and familiarization prior to final instruction.

H. Provide name, address, and telephone numbers of manufacturer's representative and Service Company for each piece of equipment so that service parts can be readily obtained.

I. Upon completion of instructions this Contractor shall provide step by step typed procedures to test and operate each piece of equipment including detailed cross referenced drawings to procedure outlined so that all equipment may be tested, shutdown, turned on or bypassed by the Owner's representative.

J. This Contractor shall provide spare part kits for the following:

K. Commissioning of systems to be provided by authorized commissioning agent and not this sub-contractor. Commissioning of systems to be as directed by owner. Commissioning of selected systems shall be provided by and secured by owner. Refer to Section 18000 of General Specifications.

L. The Plumbing Contractor shall provide 3 days (8 hours per day) per each system to assist the commissioning agent in their procedures.

1.23 COORDINATION DRAWINGS

A. Before materials are purchased, fabricated or work is begun, each Subcontractor shall prepare and obtain approval of coordination drawings, and sections for all floors/areas, including buried system/services, resulting in one (1) set of all-Trade-composite at 3/8" scale drawings, showing the size and location of all equipment, in the manner described here-in-under General Requirements. Architects review and approval of coordination drawings must be obtained prior to any fabrication or installation of any equipment or systems.

B. Coordination drawings are for the architect's use during construction and shall not be construed as shop drawings or as replacing shop drawings. The coordination drawings, when corrected for actual "as-built" conditions, will be reviewed by the Architect, corrected and become the Record Drawings to be submitted to the Owner for their use.

C. The cost of producing and reproducing the drawings will be included under the Contract of each Trade, including the cost or preparation of the Architectural building outlines. The HVAC Contractor shall take the lead to produce the Architectural backgrounds, show all ductwork, piping, etc., and circulate the drawings to any of his Contractors and the other Trades (Plumbing, Fire Protection, Electrical), so that they can indicate all their work as directed by the Architect as required, to result in a fully coordinated installation.

D. Prepare a complete set of computer based MicroStation (latest version) drawings at scale not less than 3/8" equals 1'-0", showing basic layout for the structure and other information as needed for preparation of Coordination Drawings. The drawings shall indicate the layout of all specialty trade work as indicated herein and shall be designated as Coordination Drawings. The Contractors can obtain a copy of the floor plans on disk from the engineer to assist in the preparation of Coordination Drawings. The Contractor shall provide a minimum of two (2) weeks' notice to the engineer for the preparation of the disk. A signed liability release form will be required from the Contractor prior to the release of the disk by the engineer.

E. Highlight all fire rated partitions on the Coordination Drawings for appropriate coordination.

F. The main paths for the installation or removal of equipment from mechanical and electrical rooms shall be clearly indicated on the Coordination Drawings.

G. Each of the specialty trades shall add its work to the base drawings with appropriate elevations and grid dimensions. Specialty trade information shall be required for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers and for spaces in the above ceilings where congestion of work may occur such as corridors and where required, entire floors. Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. Indicate elevations relative to finish floor for bottom of ductwork and piping and conduit 2" greater in diameter.

1. Specialty Trade shall include:

a. Plumbing system

b. HVAC piping and equipment.

c. Electrical system

d. ATC system

e. Structure

H. Upon completing their portion of the Coordination Drawings, each specialty trade shall sign, date and return Coordination Drawings to the Contractor.

I. Where conflicts occur with placement of materials of various trades, the General Contractor shall be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialized and dated by the affected specialty trade Contractor. The General Contractor shall then final date and sign each drawing.

J. Fabrication shall not start until Coordinate Drawings have been distributed to all parties as indicated herein.

K. Format: Coordination Drawings (plan only) shall be done using MicroStation on PC Format disks shall be given to the architect for future transfer to Owner. Coordination Drawings will be used as basis for as-built drawings.

L. Distribution of Coordination Drawings:

1. The General Contractor shall provide one print of each Coordination Drawing to:

a. Each specialty trade Contractor.

b. Owner

c. Construction Manager

d. Architect (for record purposes)

2. The method used to resolve interferences not previously identified shall be as in paragraph I above. Distribute revised Coordination Drawings to all parties listed above.

M. Coordination drawings include but are not necessarily limited to:

1. Structure

2. Partition/room layout, including indication of smoke and fire resistance rated partitions.

3. Ceiling layout and heights.

4. Light fixtures.

5. Access Panels.

6. Sheet metal, heating coils, boxes, grilles, diffusers, etc.

7. All heating piping and valves.

8. Smoke and fire dampers.

9. Soil, waste and vent piping.

10. Major water and gases.

11. Major electrical conduit runs, panelboards, feeder conduit and racks of branch conduits. Motor control centers, starters and disconnects.

12. All equipment, including items in the Contract as well as O.F.C.I. and O.F.I. items.

1.24 RECORD DRAWINGS/AS-BUILT DRAWINGS

A. The Plumbing Subcontractor shall maintain current at the site a set of his drawings on which he shall accurately show the actual installation of all work provided under his Contract indicating hereon any variation from the Contract Drawings, in accordance with the General Conditions and Division 1. Changes, whether resulting from formal change orders or other instructions issued by the Architect, shall be recorded. Include changes in sizes, location, and dimensions of piping, equipment, fixtures, etc.

B. The Plumbing Subcontractor shall indicate progress by coloring-in various piping, equipment and associated appurtenances exactly as they are erected. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.

C. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be inspected periodically by the Architect and Owner and they shall be corrected immediately if found either inaccurate or incomplete. This procedure is mandatory.

Failure to comply with this requirement could result in a reduction of the monthly payment requisition recommended.

D. At the completion of the job, these prints shall be submitted to the General Contractor and then to the Architect for final review and comment. The prints will be returned with appropriate comments and recommendations. These corrected prints, together with corrected prints indicating all the revisions, additions and deletions of work, shall form the basis for preparing a set of As-Built Record Drawings.

E. The Plumbing Subcontractor shall be responsible for generating As-Built Record Drawings utilizing MicroStation. A bound set of plans, as well as the computer files, on disk, shall be turned over to the Architect for review. After acceptance of the As-Built documents by the Architect, the Plumbing Subcontractor shall make any corrections necessary to the As-Built documents and prepare one reproducible set of drawings as well as bound blueprint set(s) (quantity as determined by the Architect) for distribution to the Owner via the Architect.

F. The Plumbing Subcontractor may use the computer drawing files used for coordination drawings or obtain the Engineers most recently updated computer drawing files. The updated drawings may not include all changes made during the course of construction and it shall be the Plumbing Subcontractors responsibility to update the As-Built documents to include all changes brought forth to the project resulting from bulletins, request for information (RFI's), change orders, etc. The Engineer will not be responsible for updating the computer files.

G. Included with the above shall be a complete drawing list and a standard layering system, which shall be required to be maintained within the As-Built Record MicroStation (latest version) documents.

H. The As-Built MicroStation (latest version) documents required shall be in addition to other requirements stated elsewhere.

1.25 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. For Insulation: Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. Prepare and submit shop drawings in accordance with the requirements herein before specified, and with the Shop Drawings, Product Data and Samples in Division 1 in the manner described therein, modified as noted hereinafter.

D. All shop drawings shall have clearly marked the appropriate specification number of drawing designation, for identification of the submittal.

E. Disposition of shop drawings shall not relieve the Plumbing Subcontractor from the responsibility for deviations from drawing or specifications, unless he has submitted in writing a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Engineer, nor shall such disposition of shop drawings relieve the Plumbing Subcontractor from responsibility for errors in shop drawings or schedules.

F. Shop drawing data shall include, but not be limited to, the following:

1. Manufacturer's model and catalog data.

2. Complete connection diagrams for all Trades.

3. Dimensions, capacities, ratings, materials, finishes, etc.

G. Each shop drawing is required to bear the review stamp of each Contractor associated with installing the equipment and/or processing the document.

H. All final approved shop drawings shall be included in the required O & M manuals.

I. Shop drawings shall include but shall not be limited to the following:

1. Plumbing work layout, including location and sizes of piping, valves, cleanouts, equipment, connections, drains, test stations, and all other accessories

2. Equipment cuts and manufacturer's documentation for

a. Plumbing fixtures and trim, including fixture supports and fasteners

b. Equipment

c. Piping and fittings

d. Drainage specialties

e. Insulation

f. Vibration isolation

g. Seismic bracing

h. Pipe sleeves, plates and escutcheons

i. Fire stopping and smoke stopping,

j. Valves, gauges, drains, thermometers

k. Hangers, supports, fasteners

l. Access panels

m. Sumps, pits, pumps, controllers

n. Reduced pressure backflow preventers

o. Meters

p. Regulators

q. Expansion joints, anchors and guides

1.26 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.27 DELIVERY, STORAGE AND HANDLING

B. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.28 WATERPROOFING, FLASHING AND COUNTER-FLASHING

A. Plumbing Subcontractor shall coordinate with the General Contractor the counter-flashing of all piping and equipment provided by him, which pierce roofs, walls

and other weather-barrier surfaces. Waterproofing and counter-flashing shall be provided by the General Contractor. Refer to Division 1.

B. Any leaks developed due to Plumbing Subcontractor's work shall be repaired at the Plumbing Subcontractor's expense, to Architect's satisfaction.

C. All water proofing, flashing and counterflashing work shall be performed in a workmanlike manner to assure weatherproof installation. Any leaks developed due to this Contractor’s work shall be repaired at his expense, to the Architect’s satisfaction.

D. Pipes passing through slabs shall have the sleeve extended above floors as hereinafter specified to retain any water and the space between the pipe and sleeve caulked with fire proof and smoke proof material. The top shall be sealed with lead and the bottom shall be sealed with monolastic caulking compound. The space between the outside of the sleeve and the floor slab shall be caulked watertight sufficiently to hold 2 inches of standing water.

E. All flashing required for piping penetrations shall be formed by a sheet copper pan.

1.29 MISCELLANEOUS IRON AND STEEL

A. Except where specifically indicated for the General Contractor to provide supports, Plumbing Subcontractor shall provide all steel supports and hangers required to support all equipment or materials provided under this Contract.

B. All supports shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets and framework shall be properly sized and strongly constructed.

C. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be performed by experienced metal working mechanics. Members shall be straight and true and accurately fitted.

D. Drilling, cutting and fitting shall be done as required to properly install the work and accommodate the work of other Trades as directed by them.

E. Members shall be generally welded except that bolting may be used for field assembly where welding would be impractical.

F. All shop and field fabricated iron and steel work shall be cleaned and dried and given a coat of rust inhibiting paint on all surfaces and in all openings and crevices

1.30 HOUSEKEEPING PADS, CUTTING AND PATCHING

A. All concrete and masonry equipment bases and pads, curbs, chases, pockets and openings required for the proper installation of the work under this Contract will be provided by the General Contractor/Construction Manager/General Contractor, using information, as shown on the drawings and/or as required and furnished by the Plumbing Contractor. At a minimum concrete bases and housekeeping pads shall be 4 inches high and extend 3 inches on all sides beyond equipment (for all base mounted equipment).

1.31 CORE DRILLING

A. The Plumbing Contractor shall be responsible for core drilling all holes (up to and including 12” in size) required for work under his Contract and with the written approval of the Architect.

B. In no case shall the Plumbing Contractor cut into any structural elements without the written approval of the Architect

1.32 PIPE SLEEVES AND ESCUTCHEONS

A. Where pipes pass through all walls, the Plumbing Contractor shall provide and set individual sleeves for each pipe and all other work under his charge, as necessary for passage of all pipes. Sleeves shall be of sufficient size to provide ½ inch air space around the pipe passing through it. All openings shall be sealed, smokeproofed and made tight. The Plumbing Contractor shall be responsible for the exact location of sleeves provided under this Contract and shall coordinate all requirements for piping sleeves.

B. All exposed piping penetration of walls and ceilings shall be fitted with escutcheons.

C. When plastic piping is used the penetration shall be protected with a fire rated collar to maintain the assembly rating.

1.33 IDENTIFICATION OF MATERIALS

A. All equipment used in the plumbing systems shall have a permanently attached nameplate identifying the manufacturer, service, size, serial number or model number, etc. The nameplates shall be kept clean and readable at all times.

B. Each item of equipment such as pumps, water heaters, grease traps, interceptors, etc., shall be identified by a permanently attached nameplate.

C. A legend showing the service and an arrow indicating the direction of flow shall be applied on each pipe installed by the Plumbing Subcontractor.

1.34 VALVE TAGS AND CHARTS

A. All valves on pipes of every description shall be provided with valve tags. Tags shall be provided by the Plumbing Subcontractor for the work under their charge.

B. All valves on equipment shall be provided with valve tags.

C. The Plumbing Subcontractor shall provide for his work valve charts of all systems.

1.35 ALTERNATES

A. General

1. Related requirements specified elsewhere:

a. Summary of Work: Division 1 - Section 01 10 00.

b. Alternates: Division 1 - Section 01 23 30.

B. Description

1. This section describes the changes to be made under each alternate.

2. Alternate proposals shall include the difference in price (addition or deduction) from the base bid, for substitution, omitting or adding to materials or construction required by the Bidding Documents as pat of the base bid construction work.

3. The difference in price shall include all omissions, additions, adjustments of all trades as may be necessary because of each change.

4. Coordinate pertinent related work and modify surrounding work as required to complete the project under each alternate designated in the Owner Contractor Agreement.

C. Schedule of Alternates

1. Alternate Bid [Number]: [Description]

a. [Detailed Description] (The majority of this portion of the specification should be obtained by the Architect.)

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. All materials submitted for use on this project shall be manufactured in North America unless there is no source of supply available to meet this criteria. Source documentation shall be submitted upon request.

2.03 DISCLAIMERS

A. No materials used in the Plumbing system shall contain asbestos.

B. At the request of the Architect submit documentation of this Product Approval for any and/or all products to be used.

2.04 SPECIAL FITTINGS

A. All wall hung fixtures shall be supported on combination wall hung supporting fitting and where applicable chair carrier furnished complete with special foot piece and all necessary bolts, nuts, washers and gaskets. The adjustable nipple for water closets between the cast iron fitting and the closet bowl shall be threaded cast iron. Secure all foot pieces to floor slab.

B. Close coordination is required between plumbing contractor and tile contractor in closet installation. Maintain 1/16" clearance between finished wall and back of closet and follow manufacturer's details in installing couplings to insure tight seal at closet outlet. Closet hanging templates must be used.

2.05 HANGERS AND SUPPORTS

A. All hangers, supports, clamps and rods shall be corrosion resistant (stainless steel or electro-galvanized). All hangers shall be UL listed.

B. All piping shall be supported from the building structure by means of approved hangers and supports. Piping shall be supported to maintain required grading and sloping of lines, to prevent vibration and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.

C. Maximum spacing of hangers on runs of steel, copper or brass piping shall be as follows:

Schedule -Hanger Spacing in Feet/Pipe Material

Pipe Size (inches)	Steel	Copper or Brass
½”	7	5
¾”	7	5
1	7	5
1 ¼”	10	6
1 ½”	10	8
2”	10	8
2 ½"	12	10
3	12	10
4	12	10

D. Where codes having jurisdiction require closer spacing, the hanger spacing shall be as required by code in lieu of the distances specified herein.

E. Hangers for uncovered (uninsulated) copper piping shall be factory applied plastic coated steel band or copper plated.

F. Where three or more pipes are running parallel to each other, factory fabricated gang type hangers with the pipe saddle clips or rollers may be used in lieu of the hereinbefore specified clevis hangers. These hangers shall be sized to provide for insulation protectors as hereinafter specified. Pipe saddle clips shall be not less than 16-gauge metal and shall be plastic coated when installed with uninsulated copper piping. .

G. All vertical drops and runouts, including insulated pipes, shall be supported by extension type split ring type hangers. These hangers shall be plastic coated when used on uncovered copper tubing. Supports on insulated piping shall be sized to fit the outside diameter of the pipe insulation.

H. Field painting or spraying of hangers in lieu of plastic coating will not be accepted.

I. All horizontal piping shall be suspended from the building by mild steel rod connecting the pipe hanger to inserts, beam clamps, angle brackets, and lag screws as required by the Building Construction in accordance with the following:

Copper and Plastic Pipe Size (inches)	Rod Diameter
½”-2”	3/8”

2 ½”-5”	½”
6	5/8”
8”-12”	¾”

Steel Pipe Size (inches)	Rod Diameter
½”-2”	3/8”
2 ½”-3 ½”	½”
4”-5”	5/8”
6”-8”	¾”
10”-12”	7/8”

J. All hangers on insulated lines shall be sized to fit the outside diameter of the pipe insulation. Provide pipe covering protection saddles at all hangers on the insulated lines.

K. Remove rust from all ferrous hanger equipment (hangers, rods and bolts) and apply one coat of rust inhibitor which does not contain lead immediately after erection.

L. Piping at all equipment and control valves shall be supported to prevent strains or distortions or transmission of vibration in the connected equipment and control valves. Piping at equipment shall be supported to allow for removal of equipment, valves, and accessories with a minimum of dismantling and without requiring additional support after these items are removed.

M. All piping installed under this SECTION of the Specification shall be independently supported from the building structure and not from the piping, or conduit of other trades. All supplementary steel, including factory fabricated channels, required to meet the requirements specified herein, shall be furnished and installed by the Plumbing Subcontractor.

N. All supplementary steel, including factory fabricated channels and associated accessories throughout the project for this SECTION of the Specifications both suspended and floor mounted shall be furnished and installed by the Plumbing Subcontractor and shall be subject to the approval of the Architect/Engineer.

O. Hanger assemblies (hanger, plates, rods, and screws) installed for chrome plated piping shall also be chrome plated.

P. Safety straps shall be installed with all beam clamps.

Q. Piping shall be supported on both sides of building expansion joints and listed flexible fittings/flexible connections used to allow for the movement of the building and structure without impact to the piping systems traversing the joint.

R. Hanger attachment

1. This section is a performance specification.

2. All anchors shall be ICC listed for their use.

3. All hangers shall be secured by approved inserts or expansion shields wherever possible and practicable, self-tapping inserts/attachments are not allowed. Inserts and shields shall be UL listed. Drilling where required shall be done by the Plumbing Subcontractor under this SECTION of the Specifications. Powder, explosive or pressure-driven inserts, or powder, explosive or pressure-actuated installation equipment shall not be allowed.

4. Post-installed anchors shall be as manufactured by Hilti, Powers or Strongtie. Contact the manufacturer for product related questions.

5. Anchor capacity used in design shall be based on the technical data published by the manufacture or such other method as approved by the structural engineer of record.

6. Substitution requests for alternate products must be approved in writing by the structural engineer of record prior to use. Contractor shall provide calculations demonstrating that the substituted product is capable of achieving the performance values of the specified product.

    a. Substitutions will be evaluated by their having an ICC ESR (Evaluation Services Report) showing compliance with the relevant building code for seismic uses, load resistance, installation category, and availability of comprehensive installation instructions.

7. Install anchors per the manufacturer instructions, as included in the anchor packaging, and per their ICC listing.

8. The contractor shall arrange an anchor manufacturer's representative to provide onsite installation training for all of their anchoring products specified. The structural engineer of record must receive documented confirmation that all of the contractor's personnel who install anchors are trained prior to the commencement of installing anchors.

9. Anchor capacity is dependent upon spacing between adjacent anchors and proximity of anchors to edge of concrete. Install anchors in accordance with spacing and edge clearances coordinated with the hanger manufacturer and the structural engineer.

10. Reinforcing bars in the concrete structure may conflict with specific anchor locations. Reinforcing bars shall not be cut under any circumstances. The contractor shall review the structural drawings and shall undertake to locate the position of the reinforcing bars at the locations of the concrete anchors, by hilti ferroscan, gpr, x-ray, chipping or other means.

S. All below slab piping shall be supported from the slab above with stainless steel hangers and hardware.

2.06 INTERIOR VALVES, FLANGES AND UNIONS

A. General: All systems under this Section shall be provided with valves to permit complete and/or sectional control of the system. They shall be located to permit easy operation, replacement and repair. They shall be installed where shown on the drawings, or as herein specified. They shall be the product of one manufacturer and shall be as manufactured by one of the following companies or approved equal:

	……Service	.....Acceptable Manufacturers.....
	Water Valves	
	Ball Valves:	Apollo Watts
	Gate Valves	PECO
	Check Valves	Apollo
	Pressure Reducing/Regulating Valves	Watts
	Drain Valves	Apollo
	Backflow Preventors including Reduced Pressure Principle Assembly	Zurn
	Wall Hydrants and Hose Bibbs	Chicago

	Gas Valves	
	Shut off Valves	Apollo
	Check Valves	Circle Valve
	Force Main Valves	
	Shut Off Valves	PECO
	Check Valves	PECO

B. All control valves installed more than ten feet above the floor in a mechanical room shall be provided with means for remote operation (chain operator or gear operator with handle extension).

C. Water Valves

1. All water valves shall be lead free.

2. All valve stems on piping systems that are insulated shall be extended to accommodate thermal insulation.

3. Isolation/shut-off valves 2" and smaller shall be 2-piece ball valves, all bronze body, full port, Teflon seated stainless steel ball designed for 600 psi water, solder ends, stainless steel stem, lead free. Watts B-6081-G, Apollo 77-240, Nibco S-585-70-66.

4. Drain valves shall consist of hose end drain or ball valve with cap and chain, lead free. Provide at all low points in water piping system and at the base of all risers so that entire system may be drained.

5. Check valves shall be horizontal swing free way type for 3" and smaller, lead free

6. Pressure Reducing/ Regulating Valve Constant Outlet Pressure

a. The Pressure Reducing / Regulating Valve shall be a pilot operated diaphragm valve designed to automatically reduce a fluctuating higher upstream pressure to a constant lower downstream pressure regardless of varying flow rates, and sustain a minimum upstream pressure.

b. The main valve shall be a hydraulically operated, single

diaphragm actuated, globe pattern valve. Y-pattern valves shall not be permitted. The valve shall contain a disc and diaphragm assembly that forms a sealed chamber below the valve cover, separating operating pressure from line pressure. The diaphragm shall be constructed of nylon reinforced Buna-N, and shall not seal directly against the valve seat and shall be fully supported by the valve body and cover. Rolling diaphragm construction will not be allowed and there shall ne not pistons operating the main valve or any pilot controls.

c. The main valve body and cover shall be Ductile Iron ASTM A536, and all internal cast components shall be Ductile Iron or CF8M (316) Stainless Steel. All Ductile Iron components, including the body and cover, shall be lined and coated with an NSF 61 Certified Epoxy Coating applied by the electrostatic heat fusion process. All main valve throttling components (valves seat and disc guide) shall be Stainless Steel. The valve body and cover must be machined with a 360-degree locating lip to assure proper alignment.

d. The disc and diaphragm assembly shall contain a BUNA-N synthetic rubber “Quad Seal” that is securely retained on 3-1/2 sides by a disc retainer and disc guide. Diaphragm assemblies utilizing bolts or cap screws for component retention will not be permitted.

e. The exposed portion of the Quad Seal shall contact the valve seat and seal drip-tight. The disc and diaphragm assembly must be guided by two separate bearings, one installed in the valve cover and one concentrically located within the valve seat, to avoid deflection and assure positive disc-to-seat contact. Center guided valves will not be permitted. All necessary repairs shall be made from the top of the valve while the body remains in line.

f. Pilot control systems shall contain a Flow Clean Strainer, Fixed Orifice Closing Speed, Adjustable Opening Speed Control, Pressure Sustaining Pilot and Pressure Reducing Pilot. All pilot control systems shall be utilized copper tubing and brass fittings regardless of valve size. The adjustment range of the pressure sustaining pilot shall be 20-200 psi and the pressure reducing pilot shall be 30-300 psi.

g. The Pressure Reducing / Regulating Valve shall be a pilot operated diaphragm valve designed to automatically reduce a fluctuating higher upstream pressure to a constant lower

downstream pressure regardless of varying flow rates, and sustain a minimum upstream pressure.

h. The main valve shall be a hydraulically operated, single diaphragm actuated, globe pattern valve. Y-pattern valves shall not be permitted. The valve shall contain a disc and diaphragm assembly that forms a sealed chamber below the valve cover, separating operating pressure from line pressure. The diaphragm shall be constructed of nylon reinforced Buna-N, and shall not seal directly against the valve seat and shall be fully supported by the valve body and cover. Rolling diaphragm construction will not be allowed and there shall ne not pistons operating the main valve or any pilot controls.

i. The main valve body and cover shall be Ductile Iron ASTM A536, and all internal cast components shall be Ductile Iron or CF8M (316) Stainless Steel. All Ductile Iron components, including the body and cover, shall be lined and coated with an NSF 61 Certified Epoxy Coating applied by the electrostatic heat fusion process. All main valve throttling components (valves seat and disc guide) shall be Stainless Steel. The valve body and cover must be machined with a 360-degree locating lip to assure proper alignment.

j. The disc and diaphragm assembly shall contain a BUNA-N synthetic rubber “Quad Seal” that is securely retained on 3-1/2 sides by a disc retainer and disc guide. Diaphragm assemblies utilizing bolts or cap screws for component retention will not be permitted.

k. The exposed portion of the Quad Seal shall contact the valve seat and seal drip-tight. The disc and diaphragm assembly must be guided by two separate bearings, one installed in the valve cover and one concentrically located within the valve seat, to avoid deflection and assure positive disc-to-seat contact. Center guided valves will not be permitted. All necessary repairs shall be made from the top of the valve while the body remains in line.

l. Pilot control systems shall contain a Flow Clean Strainer, Fixed Orifice Closing Speed, Adjustable Opening Speed Control, Pressure Sustaining Pilot and Pressure Reducing Pilot. All pilot control systems shall be utilized copper tubing and brass fittings regardless of valve size. The adjustment range of the pressure sustaining pilot shall be 20-200 psi and the pressure reducing pilot shall be 30-300 psi.

7. Drain Valves

   a. Drain valves shall be all bronze ball valves of 2 piece construction, soldered ends, full port, Teflon seated stainless steel ball, threaded ends with sweat adapters, and male hose adaptors with brass cap and chain.

   b. Piping up to ½" diameter shall have ½" x ¾" hose end valves.

8. Backflow Preventers

   a. Shall be lead free.

   b. Provide reduced pressure backflow preventors as shown on the drawings, complete with control valves, repair kit, test kits, pressure gauges and air gap fittings, with drains piped to nearest floor drain. Valves shall be mounted 4'-0" centerline above the floor and properly secured to the wall or floor stand mounted. Devices shall be tested and certified under AWWA Std. No. C506 and FCCCHR of USC manual, Section 10.

      1. Backflow preventor on main domestic water service shall be reduced pressure principal assembly device with FDA approved epoxy coated cast iron check valve bodies with bronze seats, FDA approved epoxy coated cast iron relief valve with stainless steel trim, bronze body ball valve test cocks, outside screw and yoke gate valves with resilient wedges and air gap fitting.

   c. In-line vacuum breakers for continuous pressure shall have bronze body, stainless steel working parts, rubber diaphragm and disc, 3/8" female inlet and outlet connections for in-line continuous pressure applications, polished chrome plated.

   d. Backflow preventors with intermediate atmospheric vent shall have all bronze construction with stainless steel internal parts, threaded union connections and built-in strainer, to be used for ice-maker connections and locations as called for on drawings.

   e. Provide flood protection shutdown valve on the supply to the backflow preventer and a water flow switch controller with time delay on the drain discharge line.

      1) Watts ACV 113-6RFP control valve or equal with FS99 detector. Provide ACV with 110V power, system shall be

wired to the BMS.

9. Hose Bibb

a. Hose bibs shall be polished chrome plated, solid cast brass construction, rigid spout with ¾" hose end thread and integral atmospheric vacuum breaker, tee handle, slow compression renewable cartridge, wall flange and ¾" female inlet.

C. Gas Valves

1. All gas valves shall have AGA approval, or approval from another testing agency that is acceptable to the Authority Having Jurisdiction, and bear the label of AGA or the other testing agency. Valve shall be UL Listed.

2. Natural gas shutoff valves 2" and smaller shall be bronze ball valves, threaded end,150 psig maximum working pressure, AGA approved and UL Listed.

3. Over 2" size natural gas shutoff valves shall be lubricated plug cocks, 175 psig maximum working pressure, threaded or flanged ends.

4. Check valves on natural gas piping shall be disc type check valves, brass body, aluminum soft seated disc threaded ends up to and including 2" size. Valves larger than 2" size, ends shall be threaded or flanged.

5. Emergency natural gas shutoff valve cabinet custom steal cabinet with 12" x 12" x 6" with special mounting trim., threaded and lubricated plug cock. Cabinet shall be painted as directed by architect prior to installation. Provide operating wrench for each valve to the owner.

D. Flanges

1. Flanges shall be companion type, faced and drilled for not less than 125# steam working pressure except flanges on portions of the water service that are subjected to pressures above 125# shall be 250# rated, and all shall be complete with necessary adapter, and shall be of size and material of adjacent piping.

E. Unions

1. Unions shall be suitable for working pressure of not less than 150# and shall be of size and material of adjacent piping.

2.07 PIPE MATERIALS

A. Piping and fittings located in air plenums shall be smoke-proof and non-combustible, in compliance with the flame and smoke spread ratings of ASTM E84.

B. Ductile Iron Pipe and Fittings - Water Services

1. Thickness Class 52 cement lined ductile iron pipe conforming to AWWA C151-7, flanged ends.

2. Fittings shall be ductile iron, cement lined, 250 psi rating, Class 2, short body pattern to match spigot gland and rubber gasket on adjoining pipe or fitting.

3. Shall be used for domestic water services outside of building. Shall be used for domestic service within building for piping 8" in size.

4. On riser up from below floor, or out from wall, at service entrances, fitting shall be flanged. See service entrance detail on drawings.

5. Joining gaskets shall be plain rubber Type A, ANSI A 21.11 and ASTM F 36.

C. Hubless Cast Iron Soil Pipe and Fittings -use for clear water waste and storm conductor lines not buried.

1. Shall be CISPI designated.

2. Hubless cast iron soil pipe ASTM A888 with Husky or Mission Rubber 4-band clamp.

3. Fittings shall be joined with No-Hub soil pipe couplings conforming to ASTM C1540. Acceptable couplings are Husky SD-4000 manufactured by Anaheim Foundry, Ideal Heavy-Duty HD or Mission Rubber Company Heavy Weight couplings. Couplings shall be manufactured in conformance with CISPI Standard 301-90. Clamps and shields shall be Type 304 stainless steel. Screws shall be Type 305 stainless steel. Sealing gasket shall be neoprene in accordance with ASTM -C564. Pipe sizes up to and including 4” shall have 4 clamps and shall be 3” wide. Pipe sizes 5” and larger shall have 6 clamps and shall be at least 4” wide.

D. Cast Iron Soil Pipe and Fittings -use for clear water waste and storm conductor lines buried/below slab.

1. Shall be CISPI designated.

2. Service weight cast iron pipe ASTM A74, bell and spigot joints with rubber resilient gasket.

E. Cast Iron Soil Pipe And Fittings Specification (New Age Epoxy Coated) - use for clear water waste and storm conductor lines buried/below slab in corrosive soil conditions.

1. No-hub two-part epoxy coated cast iron soil pipe and fittings shall be certified to conform to ASTM A-888-11.

2. Epoxy coating shall be 2.5 mil thickness on exterior and 5.0 mil thickness on interior for superior adhesion, chemical (acid and alkali), durability, fire resistance and superior flow characteristics.

3. All pipe shall be bored on the interior prior to application of epoxy coating to remove any imperfections. Two part epoxy coating shall be sprayed on for superior coating, performance and aesthetic appeal.

4. Epoxy coated cast iron soil pipe and fittings shall be tested to be nonreactive from 2-12pH for thirty days.

5. Epoxy coated shall not sag, cold flow or become soft. Two part epoxy coating resists cavitation and cathodic disbondment.

F. Copper Tubing and Fittings (Type L) -use for all interior water piping.

1. Tubing to be Type L hard temper conforming to ASTM Specification No. B88-99, for assembly with wrought copper or bronze fitting, or with roll grooved fittings. All soldered joints shall be made with ASME Standard BWS/A5.8 lead free solder.

2. May be used with Victaulic Copper Grooved Fittings.

a. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved product utilized shall be supplied by the same manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

b. Couplings: Copper tube dimensions, ASTM A536 ductile iron housing sections, cast with angle-pattern bolt pads to provide system rigidity upon visual metal-to-metal pad contact with no torque requirement, coated with copper-colored enamel; synthetic rubber gasket suitable for water, and bolts and nuts. Victaulic Style 607. Designs that permit spaces or gaps at bolt pads or

require a torque per written manufacturers installation instructions not permitted.

c. Flange Adapters: Copper tube dimensions, ASTM A536 ductile iron casting, coated with copper-colored enamel, flat faced, for incorporating flanged components with ANSI Class 125 and 150 bolt-hole patterns to a grooved piping system. Victaulic Style 641.

d. Mechanical T: Victaulic Style 622 or equal.

3. May be used with Press Fit type fitting system.

a. Press Fittings shall conform to the material requirements of ASME B16.18 or B16.26. Fittings shall be Copper or Copper Alloy with factory installed EPDM sealing elements.

b. Press Fit system shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer.

c. All fittings must be from the same manufacturer.

d. Installers shall be trained by the manufacturer's local representative.

4. Mechanically formed Tee Fittings.

a. Mechanically extruded outlets shall be formed by drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three (3) times the thickness of the branch wall. Extruded outlets shall be perpendicular to the axis of the run tube (header).

b. The inner branch tube end shall conform to the shape of the inner curve of the tube. Insertion of the branch tube shall be controlled to assure alignment with specified depth into the collar without extending into the flow stream so as to provide internal reinforcement to the collar.

c. Branches can be formed up to the run tube size as shown in ASTMF 2014. Forming procedures shall be in accordance with the tool manufacturer's recommendations.

d. All joints shall be brazed using either Copper-Phos Rod (BCup-2), SIL-FOS or ASTM equivalent in accordance with ASME B31.9 2004, paragraph 928.1

5. May be used above ground for storm conductor piping in lieu of cast iron soil pipe and shall be used for indirect waste piping where space is limited or where called for on the drawings, except urinal waste piping shall remain cast iron. Fittings shall be made using lead-free solder or Press Fit as specified above.

G. Black Steel Piping and Fitting use for Natural Gas

1. Black steel pipe shall be Schedule 40 conforming to ASTM Designation A53 (seamless type). Fittings shall be black malleable (threaded or flanged) 150 pounds, conforming to ASA Designation B16.3. Shall be used for interior gas. Gas pipe dropping in concrete block walls shall be factory wrapped with corrosion resistant covering No. X-TRU coat or scotch kote.

2. All gas piping 3" and over and all buried gas piping shall be joined by welded connections, except where detailed otherwise.

3. All natural gas piping systems operating at 14”WC or greater pressure shall be welded connections and flanged valves, regulators, meters, etc.

4. Gas piping that is to be installed in block walls shall be protected by polypropylene pipe covering.

2.08 DRAINAGE SPECIALTIES

A. Before setting any drains, carriers, cleanouts or wall plates, obtain from the Construction Manager/General Contractor the exact information relative to the finished grades of the top of the drains and partition locations. All drainage specialties shall be of the size noted on the drawings and shall be equal to the figure numbers scheduled below. Drainage specialties may be Zurn, Josam, or JR Smith Company.

B. Floor Cleanouts

1. Floor cleanouts shall consist of dura-coated cast iron body, no hub or speed set outlet, tapered threaded plug, adjustable nickel bronze top, J.R. Smith or approved equal.

For concrete floor – J.R. Smith Model 4025 or approved equal

For heavy traffic unfinished areas J.R. Smith Model 4220 with cast iron top or approved equal.

C. Drains

1. General

a. Floor drains, trench drains, area drains, etc., shall be of one manufacturer and shall include all options and accessories as scheduled on the drawings, or as required by the installation conditions. Plumbing subcontractor shall be responsible for reviewing the architectural plans and details to determine these installation conditions.

b. Installation condition to be anticipated include, but are not necessarily limited to;

1) Square or round tops

2) Heel proof grates

3) Adjustable grates

4) Light duty, medium duty and heavy duty grates

5) Solid grates

6) Hinged grates

7) Oblique Grates

8) Solid or perforated extensions

9) Sediment buckets

10) Flashing clamps

11) Multiple outlets

12) Side outlets

13) Inside caulk, no-hub or threaded outlets

14) Vertical expansion joints

c. Drains connected to storm systems, whenever connected below the highest drain in the building, shall be provided with a means of preventing backflow of water from the upper level, either integral to the drains, or a pipe fitting (back water valve) suitable for the installation conditions.

2. Refer to drawings for drain schedules.

3. Area Drain-1

   a. Zurn or approved equal

   b. Duco cast iron body and flashing collar with 8” bronze standpipe and polished bronze dome. Contractor to specify standpipe length when ordering; coordinate with the landscape contractor

   Area Drain-2

   a. Zurn or approved equal

   b. 14” square, duco cast iron body and flashing clamp with seepage openings, heel proof, nickel bronze secured grate, extension to suit.

2. Floor Drains

   a. Mechanical rooms for pump seal drains, indirect wastes, boiler drains (after quenching), boiler and water heater stack drains (after neutralization):

      1) Zurn or approved equal.

      2) Zurn-541.

      3) Trap Primer connection.

      4) 12” square x 10” deep coated cast iron body with bottom outlet, suspended sediment bucket, seepage pan and combination membrane flashing clamp and frame.

      5) Where not subject to foot traffic, less top.

      6) Where subject to personnel walking over or around, ½ or 3/4 grates, depending upon number and size of indirect wastes being served.

3. Trench Drains

   a. Shall be per DIN19580 (testing and loading of trench drain systems).

b. Modular trench drain systems

1) Coated cast iron body, deep sump outlet with sediment bucket, 12” long extension modules as need by length required, integral seepage pan and heavy duty vandal proof ,heel proof grate, clamping collar, underdeck clamp 6” or 12” wide as scheduled on the drawings, cast iron grate unless scheduled otherwise on the drawings. Number of outlet modules as scheduled on the drawings.

2) See schedules on the drawings for the sizes, and sloped and non-sloped types.

3) Length and number of sections required shall be determined by plumbing subcontractor from information provided by Architect, Landscape Architect and/or Civil Engineer.

2.09 INSULATION

A. Scope: The following piping, fittings, and valves shall be insulated:

1. All interior water piping

2. All horizontal storm conductor and clear water waste piping including drain bodies except buried piping.

3. Water, storm conductor and soil piping in exterior furred ceiling spaces and building overhangs.

4. All horizontal drainage piping collecting HVAC and other cold condensate and cold water discharges.

B. Materials: The following materials are specified:

1. Pipe insulation -fiberglass.

2. Approved manufacturers: Owens Corning, John Manville and Certain-Teed.

3. Fittings and Valves Insulation:

a. Hydraulic setting combination insulating and finishing cement.

b. Molded or fabricated fitting covers of equal thickness and identical in composition to adjacent pipe insulation.

c. Zeston premoulded fittings.

4. All materials, including vapor barrier jackets, glass cloth jackets, adhesives, etc., shall be fire retardant.

C. Insulation Thickness:

1. The piping, fittings, and valves shall be insulated per the following (minimum R value of 2.0):

a. Cold water piping: insulation shall be 1" thick and have a thermal conductivity not exceeding 0.27 Btu per inch/hr · ft^2 ·°F. (R 3.7)

b. Horizontal storm water conductors and clear water waste piping: insulation shall be 1" thick and have a thermal conductivity not exceeding 0.27 Btu per inch/hr · ft^2 ·°F. (R 3.7)

D. Finish

1. Concealed: Vapor barrier jacket on all water piping, except where flexible tubing insulation is used which requires no vapor barrier. Pre-sized glass cloth jacket may be used on hot water piping. Fittings shall be finished with pasted canvas or presized glass cloth jacket.

2. Exposed: Same as concealed except all insulation shall have factory applied 8 ounce canvas finish or pre-sized glass cloth jacket.

3. AJS Fiberglass 24 All Service Jacket.

4. Piping and fittings exposed to the elements shall be PVC jacket applied over the factory applied 8 ounce canvas finish or pre-sized glass cloth jacket.

E. Application:

1. General

a. All insulation shall be installed in strict accordance with the manufacturer's recommendations and shall be applied by a qualified Insulation subcontractor.

b. Insulation shall not be applied on any apparatus or piping until the apparatus and piping have been thoroughly cleaned, tested and accepted as tight.

2. Piping: Pipe insulation where vapor barrier jacket is required, shall be installed with vapor barrier jackets drawn tight and firmly sealed to assure a positive vaporseal. End joints shall be covered with 4-inch wide butt strips of material identical to vapor barrier jackets, and they shall be drawn tight and securely sealed. The use of staples, bands, etc., to secure insulation where vapor barrier jacket is required will not be acceptable. Pipe insulation where no vapor barrier is required shall be secured with flare type staples.

3. Fittings and Valves: Cement or moulded insulation on fittings and valve bodies shall be same thickness as adjacent covering and finished neatly to match the adjacent pipe insulation.

F. Hangers

1. Special high density inserts of calcium silicate, cellular glass and other approved material of the same thickness as adjacent insulation shall be installed at points of hanger support. Insulation inserts shall be installed at points of hanger support. Insulation inserts shall be either 180 degrees or 260 degrees and not less than 18" in length. The entire insert shall be covered with a vapor barrier facing of the same appearance and quality as the facing on the adjacent covering.

2. Insulation at hangers, anchors and supports shall be neatly cut and fitted.

3. In Lieu of #2 and #3 above: Snappitz: self locking insulated pipe supports. Insulated Pipe Supports may be provided at hanger, support, and guide locations on pipe requiring insulation. The insert should consist of either Hydrous Calcium Silicate or Polyisocyanurate Foam Insulation (Urethane) encircling the entire circumference of the pipe with a 360° galvanized steel jacket and installed during the installation of the piping system.

2.10 FIXTURES, EQUIPMENT, SUPPORTS AND FASTENERS

A. All fixtures and equipment shall be supported and fastened in a satisfactory manner. Bolt heads and nuts shall be hexagon, and exposed bolts, nuts, washers, and screws shall be chromium plated brass.

B. Where secured to concrete or brickwork walls, they shall be fastened with brass bolts or machine screws in lead sleeve type expansion shields and shall extend at least 3 inches into solid concrete brickwork.

2.11 PIPE SLEEVES AND ESCUTCHEONS

A. The Plumbing Contractor, for work under his charge, shall determine the diameter of each individual wall opening or sleeve before ordering, fabrication or installation.

B. Sleeves and inserts shall not be used in any portions of the building where their use would impair the strength or construction features of the building. Elimination of sleeves must be approved by the Architect.

C. Expect where noted otherwise in this paragraph provide chrome-plated brass escutcheons with set screw for exposed piping, in all areas. In mechanical rooms use plain brass or cast iron escutcheons suitable for painting. All escutcheons shall be sized to fit the bare pipe or insulation in a snug and neat manner. All escutcheons shall be equipped with a means of securing the escutcheon to the piping or the covering. They shall be of sufficient size to cover sleeved openings for the pipes and of sufficient depth to cover sleeves projecting above floors or beyond walls. Escutcheons shall be as manufactured by Beaton and Caldwell, Dearborn Brass or Grinnell.

D. Exterior wall sleeve through masonry walls shall be made water tight by the use of Mechanical Link Seal.

E. Pipe sleeves shall be required on all pipes passing through all walls and floors (including slabs on grade) and shall be made of Schedule 40 pipe, 16 gauge galvanized steel or 16 gauge steel as follows:

1. Sleeves on pipes passing through masonry or concrete construction shall be Schedule 40 pipe.

2. Sleeves passing through masonry partitions shall be 16 gauge steel unless required otherwise by item 1. above.

3. Sleeves on pipes passing through drywall construction shall be 16 gauge galvanized steel.

4. Sleeves on pipes passing through fire rated drywall partitions shall be 16 gauge steel.

F. Pipe sleeves shall be set as follows:

1. Set sleeves 1 inch above finish floor (6 inches at penthouses and mechanical rooms) and flush on each side of walls, except sleeves through floor occurring in walls and partitions shall terminate flush with finish floor.

2. Sleeves shall be set securely in place before concrete is poured.

2.12 SEISMIC RESTRAINT

A. This section is a performance specification.

B. The Plumbing Contractor shall provide all necessary design and materials for seismic restraint and protection of piping and devices against damage where subject to earthquakes as required for the Plumbing systems within the building and on the roof. Design shall be submitted before installation of seismic restraints. All isolation and seismic devices shall be the product of a single manufacturer. Products of other manufacturers are acceptable provided their systems strictly comply with this section of the specifications. Provide isolation materials and seismic restraints complete and as manufactured by Mason Industries, Tolco or approved equal.

C. All curbs and roof rails are to be bolted or welded to the building steel or concrete deck to attain acceleration criteria.

1. Rooftop support structures as manufactured by Miro Industries, or approved equal, shall be an acceptable product for seismic supports.

D. Scope

1. Seismic restraint is not required for systems installed in a seismic design category A or B per the IBC and the ASCE 07.

2. The work under this section in a seismic design category C, D, E or F per ASCE 07 shall include the design, furnishing and installation of all restraint devices and systems as required for the Plumbing system including, but not necessarily limited to, the following:

a. All Plumbing system piping as required.

b. Piping penetrations through floors and walls.

c. Sleeves with clearances around the outside, as recommended.

d. Equipment isolation bases.

e. Piping flexible connectors.

f. Seismic restraints for isolated equipment.

g. Seismic restraints for non-isolated equipment.

h. Certification of seismic restraint designs.

E. Submit ten (10) copies of descriptive data for all products and materials, including the following:

1. Catalog cuts and data sheets for the specific isolators, restraints and all other items to be utilized.

2. Details of methods of sleeving, smokeproofing and isolation for pipes penetrating walls and slabs.

3. Specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.

4. Calculations to support seismic restraint designs.

5. All calculations, details and other submittal materials shall be sealed and signed by a structural or civil engineer registered in the state under where jurisdiction the project is permitted and qualified to perform seismic design calculations.

6. A seismic design liability insurance certificate that must accompany all submittals.

F. Code and standards requirements shall include, but not be limited to:

1. Applicable BOCA-NBC, MSBC with any additional State or Local requirements.

2. NFPA 99 and other applicable NFPA standards.

3. All State and Local codes.

G. Manufacturers working in this section must provide a seismic design liability insurance certificate and certify their ability to provide engineering and design as required by this section. This certificate shall be submitted to the Architect for review prior to any submittals.

2.13 ACCESS DOORS AND PANELS

A. Furnish, for installation by the designated Trade as determined by the General Contractor, all access doors in locations wherever valves, drain ports, cleanouts, gauges, thermometers, equipment, etc., are installed behind masonry walls where such devices would be inaccessible for inspection, maintenance or servicing. Access doors shall be a minimum of 18" by 18" and shall be sized to suit the access requirement to service the equipment and located in a manner approved by the Architect and to meet requirements specified here and elsewhere, for specific applications.

Refer to Section 08 31 13 for additional information.

B. Doors shall be set square and flush in cooperation with the designated Subcontractors performing the work. Particular attention shall be exercised in the selection of doors for masonry walls in order that frame sizes used will match the courses of brick or block.

C. Access panels shall be flush type with 14 gauge panels and 16 gauge frames, minimum, unless otherwise noted. Each access panel shall be furnished complete with continuous piano hinge and flush screwdriver operated cam latch, with factory applied prime finish. Access panels shall be as manufactured by Inryco/Milcor, Karp Associates Inc., Babcock-Davis or equal approved by the Architect.

2.14 MECHANICAL SUSPENSION CHANNEL

A. Mechanical suspension channel shall be furnished and installed to support plumbing equipment, (pressure reducing/regulating valves, flow balancing valves, flow meters, etc.) independent of walls. Where walls back up to occupied spaces, the suspension channels shall be at least 1/2" clear of the wall and shall not be directly attached to the wall.

B. Channel shall be Unistrut, Type P3000 or approved equal. All fasteners and fittings shall be supplied to provide a complete installation as required. Channel shall be sized and mounted to allow for future piping and equipment.

C. All channel and fittings shall be furnished with the manufacturer's standard rust-proofed finish.

D. Channel shall be manufactured by one of the following: Unistrut Products Co., Kindorf, or B-Line.

2.15 BACKWATER VALVES

A. Backwater valves installed buried below slabs on grade shall be made accessible:

1. When crown of pipe is 12” or less below the finished floor, install cast iron extension and locate cover flush with finish floor.

2. When crown of pipe is between 12” and 24” below finish floor, install valve in floor access box which shall be set with box cover flush with finish floor and box shall extend to below bottom of pipe, with cut outs for running pipe through.

a. Access box shall have top, 4 sides and bottom.

b. Box shall be of a durable material suitable for direct buy and top suitable for foot traffic.

3. When crown of pipe is further than 24" below finish floor, install valve in an access pit. The access pit shall allow for entry in order to service/maintain the valve and access the cleanouts. Pit shall be cast in place concrete with an access cover as specified in other sections of the specifications.

a. Precast units can be as manufactured by Park USA of Houston Tx. Park model # BWV-1 or approved equal.

B. In-line, Flapper Type.

1. Coated cast iron body, hub inlet and offset spigot outlet, bronze threaded cover, automatic type valve seat and bronze flapper (flapper to hang slightly open during periods of non-operation.

C. In-Line, Gate Valve Type

1. Coated cast iron hub inlet and outlet, automatic flapper with "O" ring adjacent to inlet, spade type bronze gate valve with "O" ring seat adjacent to inlet, with adjustable operating screw and covered handle, non-rising stem, and cover.

2. Provide handle extension.

PART 3 - EXECUTION

3.01 COOPERATION AND WORK PROGRESS

A. The Plumbing work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Plumbing Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Plumbing Subcontractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.

B. The Plumbing Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of. or improper coordination with. other Trades or the Owner by the Plumbing Subcontractor, shall be assumed by the Plumbing Subcontractor without any additional cost to the Owner.

C. The Plumbing Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.

D. The Plumbing Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Plumbing Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.

E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Plumbing Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

F. The Plumbing Subcontractor shall be responsible for unloading all equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Plumbing Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.

G. It shall be the responsibility of the Plumbing Subcontractor to coordinate the delivery of the equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.

H. The Plumbing Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.

I. Prior to installation, the Plumbing Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of equipment to allow proper space requirements. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the

indicated equipment, the Plumbing Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

J. The Plumbing Subcontractor shall not allow any of his equipment or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment are located, such as electric rooms, electric closets, telephone or data closets. The Plumbing Subcontractor shall immediately remove any such piping or equipment.

K. The Plumbing Subcontractor shall obtain from the Electrical and HVAC Subcontractors copies of all shop drawing prints showing the ductwork piping and conduit installation as they will be put in place on the project. These drawings shall be thoroughly checked by the Plumbing Subcontractor and the routing of all piping and installation of all valves, etc., and plumbing equipment shall be coordinated with the ductwork and conduit so as to prevent any installation conflict. Such coordination shall be done prior to roughing in piping and equipment.

L. Location of all fixtures shall be verified with the Architect prior to roughing. Refer to details and wall elevations on the Architectural drawings. Mounting heights indicated on these drawings and/or specific dimensional information given to the Plumbing Subcontractor by the Architect shall take precedence over such information indicated on the Plumbing drawings.

M. Refer to all other drawings associated with this project. Any and all equipment which require plumbing services or connections, whether indicated on the Plumbing drawings or not, shall be furnished and installed as directed by the Architect.

N. Refer to the Architectural drawings for areas in which the concrete slab is poured on grade. In these areas a waterproofing membrane will be installed on the grade fill or earth prior to pouring of slab. Plumbing piping shall be installed to avoid the necessity of penetrating this waterproofing membrane. Penetration of the membrane, if required, shall only be made when specifically allowed by the Architect, and shall be made only at locations directed by the Architect.

3.02 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in 22 00 00 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and

requirements peculiar to certain items and classes or material and equipment.

2. The Plumbing Subcontractor shall obtain detailed information from manufacturers of equipment as to proper methods of installation.

3. The Plumbing Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.

4. The Plumbing Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Cutting and patching by others as necessary.

5. The Plumbing Subcontractor shall coordinate the utility service installations with the local Water and Sewer Department Utility Co.,the Owner, the Gas Company.

6. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.

3.03 MATERIALS AND WORKMANSHIP

A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, ANSI and ASTM. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.

B. Despite references in the specifications or on the drawings to materials or pieces of equipment by name, make or catalog number, such references shall be interpreted as establishing standards of quality for materials and performance.

C. Finish of materials, components and equipment shall not be less than Industry good practice. When material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect.

D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect as to the best method of approach to minimize effects of reduced access.

E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.

F. The Owner will not be responsible for material, equipment or the installation of same before testing and acceptance.

3.04 CLEANING

A. This Section of the specifications shall include the cleaning of all equipment on a day-to-day basis and final cleaning of all equipment prior to turning building over to the Owner. All necessary cleaning shall be performed to the satisfaction of the Architect.

3.05 FINAL INSPECTION

A. When all Plumbing work on the project has been completed and is ready for final inspection, such an inspection shall be made. At this time, and in addition to all other requirements in the Contract Documents, the Plumbing Subcontractor, for the work under this Contract, shall demonstrate that the requirements of these specifications have been met to the Architect's satisfaction.

3.06 SUBMITTAL AND SHOP DRAWING CHECKLIST

A. The following is a checklist of job specific items that shall be submitted as Shop Drawings by the Plumbing Sub-Contractor for review and approval by Engineer, Architect and Owner.

B. The shop drawing submittals shall contain but not be limited to the information as stated below AND as stated in each specification section.

Specification Section	Product/Category	Submittal Requirements	Submitted By Contractor
220000	Plumbing shop drawings	-All below slab piping with invert elevations shown, coordinated with structure and connections to the civil engineer’s systems.	
220000	Plumbing shop drawings	-All gas fired equipment venting and combustion air piping layouts, reviewed by the manufacturer for installation requirements.	

Specification Section	Product/Category	Submittal Requirements	Submitted By Contractor
	Coordination Drawings	-Full set of coordination drawings indicating areas of conflict and proposed solution(s).	
220000/ 030000	Concrete Housekeeping Pads	-Drawings with locations and sizes	
220000	Access Doors	-Drawings with locations and sizes	
220000	Vibration Isolation and Seismic Restraint	-Cut sheets of all items and materials, stamped and signed design drawings. See Seismic section of this specification.	
220000	Piping	-Cut sheets of all items and materials including joining methods	
220000	Valves	-Cut sheets of all items and materials	
220000	Equipment: -Meters	-Cut sheets of all items and materials, control panels, alarms, operation sequences etc.	
220000	Identification	-Cut sheets of all items and materials	
220000	Hangers and Supports	-Cut sheets of all items and materials	
220000	Drains	-Cut sheets of all items and materials	
220000/ 072100	Thermal Insulation	-Cut sheets of all items and materials	
220000	Testing Reports	-Testing report including procedure and results for each system or section of each system. Include multiple iterations as performed.	
220000	Chlorination Reports	-Reports including procedure and results for each system or section of each system and lab	

Specification Section	Product/Category	Submittal Requirements	Submitted By Contractor
		results. Include multiple iterations as performed.	
220000	Record As-Built Drawings	-Full set of drawings indicating As-Built conditions.	
220000	Operation and Maintenance Manuals (O&M's)	Complete bound and tabbed binders of all equipment maintenance manuals and recommended maintenance schedule, warranties, letter of completion.	

3.07 VERIFYING CONDITIONS

A. The Plumbing Contractor shall verify all conditions and take all measurements in the field as required to insure that all work will fit actual conditions. Field corrections to fabricated work and adjustments to adjacent work where required for the proper installation of the work will be subject to the Architect's approval. Such corrections and adjustments will be permitted only when they will not be detrimental to the appearance and function of all the work.

3.08 TESTING OF PIPING SYSTEMS

A. General

1. All piping systems shall be subjected to testing water, gas or air as noted and shall hold tight at the pressure head stated for the time interval required without adding air or water. While any system is being tested, required head or pressure shall be maintained until all joints are inspected.

2. Any points of the drainage systems to be tested with air instead of water shall be made by attaching an air compressor testing apparatus to any suitable opening and after closing all other inlets or outlets, forcing air into the systems until there is a uniform gauge pressure of 5 psi or sufficient to balance a column of mercury 10" high. This pressure shall be held without the introduction of additional air for a period of at least 15 minutes.

3. All tests shall be witnessed by the inspector having jurisdiction and the Architect/Engineer, with 48-hour notice given these authorities.

4. All equipment, material and labor required for testing any of the various systems or any part thereof shall be furnished by this Plumbing Subcontractor including all additional restraints and supports required.

5. All testing reports shall be submitted for record and for review as a part of the submittal process.

B. Clear Water Waste and Storm Water Systems:

1. Water test shall be applied to these drainage systems either in their entirety or in sections as required, after piping has been installed. If applied to the entire system, all openings in the piping system shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. If the system is tested in sections, each opening shall

be tightly closed except the highest opening in the section under test, and each section shall be filled with water but no section shall be tested with less than a 10' head of water. In testing successive sections at least the upper 10' of the next preceding section shall be tested so that no joint of piping in the building, except the uppermost 10' of the system, shall be submitted to a test of less than a 10' head of water. The water shall be kept in the system for at least 15 minutes before inspection starts; the system shall then be made tight at all points.

C. Water Piping Systems:

1. Upon completion of all water supply systems or a section of them as required, they shall be tested and proved tight under a water pressure at 150% of the working pressure but not less than 125 psi. Gauge should be located on the lowest new floor and pressure shall hold for a period of one hour without introducing additional water. The water used for testing shall be from a domestic water source of supply.

D. Exterior Water Piping Systems (Including the riser up from below the floor slab):

1. General

a. All labor, materials, instruments, devices and power required for testing shall be furnished by the Plumbing Subcontractor. All tests shall be performed in the presence and to the satisfaction of the Architect, the Danvers Water Department and such other parties as may have legal jurisdiction.

b. Repair, or if directed by the Architect, replace all defective work with new work without extra charge to the Contract. Repeat tests a directed until all work is proven to meet the requirements specified herein.

c. Restore to its finished condition, any work damaged or disturbed by tests.

d. Perform all tests herein specified and all other tests which may be required by any and all authorities or agencies to whose requirements this work is to conform.

2. Notify the Architect and all inspectors having jurisdiction, a minimum of 48 hours in advance of making any required tests, so that arrangements may be made for their presence to witness his scheduled tests. The trench shall be backfilled between joints before testing to prevent movement of pipe.

3. All new piping shall be tested hydrostatically at not less than 200psi (13.8 bars).

4. Tests for leakage shall be conducted on all portions of the pipe lines. Prior to testing, all sections of the pipe lines, including hydrants, the entire lengths of pipelines shall be released and the pipe lines completely filled with water. After allowing 3 days for absorption, the internal pressure shall be built up by use of a force pump to the 200 psi. Filling of the lines shall be done as slowly as practicable so as not to cause dirty water and serious pressure drop within the municipal system.

5. Means shall be made to vent air from the mains during the filling process. After the mains have been filled, the controlling gate valves shall be closed and the new mains kept isolated from the existing system. The new mains shall be held at static pressure for at least 3 days before test is begun.

6. The piping shall be filled and pressurized to 200psi after the 3 day period and this shall be held for 15 minutes. Then the pressure shall be dropped to the normal working pressure and then built back up to 200 psi and held for 2 hours.

7. The amount of leakage in piping shall be measured at the specified test pressure by measuring with a meter or if allowed by the Water Department pumping from a calibrated container.

8. The maximum allowable rate of leakage shall be calculated by one of the following methods. The method which results in the minimum leakage shall be the maximum allowable rate.

    a. The amount of leakage at the joints shall not exceed two quarts per hour(1.89 L/h) per 100 gaskets or joints irrespective of pipe diameter. The amount of allowable leakage specified may be increased by one fluid ounce per inch valve diameter per hour (30 ml/25/mm/h) for each metal seated valve isolating the test section.

    b. The maximum allowable amount of inflow of water to maintain the required test pressure shall not exceed 12 gallons per inch of internal diameter of the pipe lines per mile of pipes per day.

9. The test pressures shall be maintained for the full period of test. (One hour)

10. In case the specified rate of leakage is exceeded, the leaks shall be removed and replaced by and the pipe line retested, repeatedly if

necessary, at no additional expense to the Owner, until the required conditions are met. The tests shall be continued for a period of at least one hour after all leaks have been stopped and all corrective work has been satisfactorily completed and after the maximum rate of inflow of water into the pipe line as specified above has not been exceeded.

11. If, in the judgment of the Architect, it is impracticable to follow any of the foregoing procedures exactly for any reason, modifications in the procedures shall be made as approved, but in any event the Plumbing Subcontractor shall be responsible for the ultimate tightness of all pipelines within the respective leakage requirements specified herein. Any modifications to the procedures, as directed, shall be performed by at no additional expense to the Owner. All hydrants shall be pressure tested in the open position at the same time as the main line.

12. Tests shall be made in the presence of Architect and Water Department.

13. All control valves shall be fully closed and opened under system water pressure to ensure proper operation.

E. Natural Gas Piping

1. Test pressure shall be a minimum of 10 times the maximum working pressure and never less than 5 psi.

2. Test duration shall be 30 minutes for each 500ft^3 of pipe volume tested. The duration of the test shall not be required to exceed 24 hours regardless of volume.

F. Defective Work: If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests shall be repeated. All repairs to piping shall be made with new materials. No caulking of screwed joints or holes will be acceptable.

3.09 SUBCONTRACTOR'S CERTIFICATE OF COMPLETION

A. The following Contractor Certificate of Completion sheet shall be copied on to the Contractor's letterhead, filled out, Singed by the Licensed Permit Holder and sealed by an Authorized Officer of the Corporation then submitted to the Architect for Final Certificate of Occupancy. This is per 780 CMR 107.6.3.

SUBCONTRACTOR'S CERTIFICATE OF COMPLETION

PROJECT _____

PERMIT NO. _____ TYPE _____

The undersigned permit holder attests that the _____ scope as installed, is complete and to the best of his knowledge and belief, in substantial accord with the requirements of the Contract Documents and all applicable local, state and federal statutes and regulations.

By: _____ _____
Signature of License holder date

_____ _____
Printed or Typed Name License Number

(seal)

By: _____ _____
Authorized Corporate Officer's Signature date

_____ _____
Printed or Typed Name Title

3.10 IDENTIFICATION OF MATERIALS

A. Before nameplates and markers are applied, the equipment and piping shall be cleaned and painted.

B. Name plate shall be made of black surface, white core laminated Bakelite with 1" high indented letters. Nameplates shall be minimum 5" long by 3" wide and bear the equipment name as designated in the specifications. Nameplates shall be as fabricated by Seton Nameplate Co., Atlantic Engraving Co., W.H. Brady Co., or approved equal. Attach with screws or rivets only.

C. A legend showing the service and an arrow indicating the direction of flow shall be applied on each pipe installed by the Plumbing Subcontractor

D. The piping of each system shall be identified in the following locations and where directed by the Architect.

1. Pipe mains and branches – every 15'-0'

2. At each valve.

3. Each wall penetration (both sides)

4. Each riser including branch risers from mains.

5. At each piece of equipment.

6. At each change of direction

7. Near each access panel.

E. The identification of piping shall be coordinated with the Owner and comply with OSHA and ANSI A13.1 Standards for the identification of systems. Obtain approval of Architect prior to installation. The letter size and background color shall conform to the ANSI Scheme for the Identification of Piping Systems.

Outside Pipe Diameter (inches)	Letter Height (inches)
¾" to 1 ¼"	½"
1 ½" to 2"	¾"
2 ½" to 6"	1 ¼"

F. Provide all labels on all capped piping.

G. The pipe markers shall be installed on the apparatus in full view and shall be a color that is in sharp contrast with the background. Color coding to be in accordance with the standards outlined in the American Hospital Association latest publication.

H. Piping systems shall be identified with approved snap-on covers designating services and direction of flow. Location of identification covers shall be near access panels wherever possible on both sides of valves. The markers shall be as manufactured by W.H. Brady Company, Westline Products, Seton Nameplate Company or approved equal.

3.11 CORE DRILLING

A. All core drilling up to and including 12” in size required for the installation of the plumbing systems is to be done by the Plumbing Contractor. Contractor is to carry all costs for core drilling. The Construction Manager/ /General Contractor will not be responsible for any circular penetrations up to and including 12” diameter in size required for the proper installation of the plumbing systems. Locate all required openings and prior to coring any, coordinate the opening with the Construction Manager /General Contractor and all other trades. Do not disturb the existing systems. Thoroughly investigate the existing conditions in the vicinity of the required opening prior to coring. The Plumbing Contractor shall be responsible for damages to the building and its systems from the coring operations. Disturbances from coring shall be kept to a minimum.

3.12 CLEARWATER WASTE AND STORM PIPING

A. Pipes shall be plumb and parallel to building walls, beams, and columns. All horizontal lines are to be evenly pitched and properly secured with iron or steel hangers. A pitch of ¼” per lineal foot shall be maintained on all conductor lines, wherever possible.

B. Where long runs of piping require less pitch due to space restrictions, a less pitch shall be allowed on main lines 4" and over in size, but in no event should any pipeline have a slope less than 1/8" per lineal foot.

C. All pipelines shall be thoroughly put together with joints made with no-hub clamps. No hub clamps shall be torqued to manufacturer's recommendations.

D. Threaded joints shall be National Pipe Thread with pipe thread compound applied to the male threads.

E. Piping to be run straight and plumb and all offsets shall be made at an angle of not less than 45 degrees and all threaded joints shall be as specified above.

F. Carefully layout the work in advance so that the pipes will pass through the opening and permit the proper pitch to the pipelines. Due to the extensive system of ventilation and lighting systems, it will be necessary for all trades to properly coordinate their work with the work of other trades so as to avoid the necessity of taking down work installed without prior checking.

3.13 GALVANIZED STEEL PIPING INSTALLATION

A. Threaded Joints

1. Threaded components and threaded ends are examined before assembly for cleanliness and continuity of threads and are in conformance with applicable standards.

2. Compound or lubricant used on threads is suitable for the service conditions and shall not react unfavorably with either the service fluid or the piping material.

3. Threaded joints to be seal welded are made up without thread compound or lubricants.

4. When design requires threaded piping to be seal welded, seal welds shall cover all exposed threads.

5. Installation of threaded joints involves the cutting of threads and assembly of the joint. Cutting threads with a hand threader involves the following steps. Threads may also be cut with a power threader.

   a. Select the proper size of die.

   b. Clean surface of pipe. Be sure the end is square and free of burrs. Tapering the end of pipe is helpful starting the dies.

   c. Mount the threader on the pipe making sure that the taper is headed in the forward direction.

   d. Use thread cutting oil.

   e. Pressure should be applied to start dies on pipe.

   f. The thread length is correct when the outer surface of die is even with the end of the pipe.

g. Remove die and clean threads with brush or rag.

h. Apply joint compound or tape that has been approved by the Facility for the application.

i. Hand tighten fitting, then tighten to required degree of tightness with correct wrench.

B. Mechanical Joints

1. General

a. Piping, valves, fittings etc. shall be installed per the manufacturer's instructions.

2. Pipe ends shall be visually inspected in accordance with the requirements listed below.

a. The front edge of the pipe end shall be uniform with no concave/convex surface features. These features will cause improper grooving roll tracking, resulting in difficult coupling assembly.

b. If pipe cut-off is required use a mechanically guided pipe cutting tool for proper pipe end preparation. Free-hand pipe end cutting is not acceptable.

c. Square cut the pipe ends.

3. Grooving

a. Prior to grooving, the weld seams must be ground flush to the pipe surface (inside diameter and outside diameter). Grind the weld seam from the pipe end to a distance of 6 inches/152 mm back from the pipe end. This area must be smooth and free from indentations, projections, and roll marks to ensure a leak-tight seal.

b. Groove the pipe in accordance with the Victaulic AGS grooving specifications. NOTE: PIPE MUST BE ROLL GROOVED WITH THE APPROPRIATE VICTAULIC AGS ROLL SETS. REFER TO THE INSTRUCTIONS FOR THE SPECIFIC COUPLING FOR ADDITIONAL INFORMATION.

c. Clean the outside surface of the pipe, from the groove to the pipe end, to remove all oil, grease, loose paint, and dirt.

4. Couplings and Gaskets

a. Do not disassemble the coupling: Style 177 Couplings are installation ready.

b. The outside surface of the pipe/ mating component, between the groove and the pipe/mating component end, must be smooth and free from indentations, projections (including weld seams), and roll marks. All oil, grease, loose paint, dirt, and cutting particles must be removed. Measurements taken across grooved pipe/mating component ends must not exceed the maximum allowable flare diameter. Refer to current manufacturer grooving specifications for the maximum allowable flare diameter.

c. Check the gasket to make sure it is suitable for the intended service. The color code identifies the gasket grade per the manufacturer.

d. Apply a thin coat of Victaulic Lubricant or silicone lubricant only to the sealing lips of the gasket interior. NOTE: The gasket exterior is supplied with a factory-applied lubricant, so there is no need to remove the gasket from the housings to apply additional lubricant to the exterior surface.

e. Never leave a Coupling partially assembled. A partially assembled Coupling poses a drop hazard.

f. Assemble the joint by inserting the grooved end of a pipe/mating component into each opening of the coupling. The ends of the grooved pipe/mating components must be inserted into the coupling until contact with the center leg of the gasket occurs. A visual check is required to ensure the coupling keys align with the grooves in the pipe mating components. NOTE: The coupling may be rotated to ensure the gasket is seated properly.

g. When assembling couplings onto end caps, take additional care to ensure the end cap is seated fully against the center leg of the gasket.

h. Tighten the nuts evenly by alternating sides until metal to metal contact occurs at the bolt pads. The middle section of the bolt pad mating surfaces must be in full metal-to-metal contact to ensure a properly assembled joint. Make sure the housings' keys engage the grooves completely during tightening.

3.14 CLEANOUTS

A. Provide and connect cleanouts with brass caps and screws same size as pipe up to 4" and not less than 4" for larger piping at the ends of all branches on soil and waste piping, and in such other portions of the piping where run is over 50 feet. Under floor cleanouts shall be installed as detailed. Special attention is called to cleanouts in carpeted areas. Cleanouts shall have special carpet marker.

B. Cleanouts shall be installed and spaced in the piping systems per code. Cleanout shall be installed at all changes of direction greater than 45 degrees and at all changes in direction where the total sum of fittings to make the change in direction is greater than 45 degrees.

C. A building cleanout shall be provided inside the building footprint at the foundation wall where all drainage system piping exists, one cleanout per system.

D. Where stacks enter drains near walls or piers causing difficult access to end cleanouts, there shall be a vertical cleanout on the stack just above the floor with a 1/4 bend at the foot of the stack.

E. Where such conditions occur in walls or partitions, the cleanout cover shall be accessible through an opening left in the wall and covered with the flush chromium plated brass plate or access panel securely fastened in place.

F. Where test tees are installed at the base of the stack, or on the stack, they may be used as a cleanout.

G. Brass cleanouts shall be solid nut construction.

H. Provide the Owner with six wrenches for removing flush cleanout plugs.

I. Cleanouts shall be provided at the base of all stacks and at all changes of direction in the drainage piping system per code. Cleanouts shall be no more than 50’ apart on piping 4” and smaller and no more than 100’ apart on piping larger than 4”.

3.15 INTERIOR WATER PIPING INSTALLATION (COPPER)

A. Pipe used in piping assembly must be clean of dirt and obstructions and shall have ends square and reamed before butting into the fittings.

B. Cut the tube to the required length with hacksaw or tube cutter designed for copper work.

C. Remove burrs from the inside and outside of the cut edge and clean the end of the tube with steel wool or sand cloth until all discoloration is removed and metal is smooth and bright.

D. Oxides will be removed by sand cloth, brush, etc.

E. Removal of oxides or discoloration of pipe and fittings by acids or self-cleaning flux is forbidden.

F. Apply a thin, uniform and complete coating of reliable brand of water soluble soldering flux meeting the ASME Standard BWS/A5.8, lead free to the cleaned surfaces of the tube and fittings.

G. When joints are soldered, remove excess solder with a cloth or brush leaving a fillet of solder in the chamber at the end of the fitting.

H. All piping must be true and plumb and with proper pitch for draining after soldering.

I. All lines of water piping shall be protected from water hammer by air chambers and/or shock absorbers. Where air chambers are used, extend branch piping upward at least 20 times the diameter of the pipe. To install air chambers, pipe dropped into pipe spaces shall be carried full size as branches to fixtures with full size air chambers. Where shock absorbers (or shocks) are used, they shall be made accessible through access panels.

J. Furnish and install all valves required to isolate sections of the piping system extending into areas scheduled for construction at a later date. Provide any and all draw-off valves which may be required to properly chlorinate the system in sections as required by the phasing of the building. Identify future isolation and phasing valves as such with valve tags and include same on charts and as-built drawings.

K. Mechanical Joints

1. General

a. Piping, valves, fittings etc. shall be installed per the manufacturer's instructions.

2. Pipe ends shall be visually inspected in accordance with the requirements listed below.

a. The front edge of the pipe end shall be uniform with no concave/convex surface features. These features will cause improper grooving roll tracking, resulting in difficult coupling assembly.

b. If pipe cut-off is required use a mechanically guided pipe cutting tool for proper pipe end preparation. Free-hand pipe end cutting is not acceptable.

c. Square cut the pipe ends.

3. Grooving

a. Prior to grooving, the weld seams must be ground flush to the pipe surface (inside diameter and outside diameter). Grind the weld seam from the pipe end to a distance of 6 inches/152 mm back from the pipe end. This area must be smooth and free from indentations, projections, and roll marks to ensure a leak-tight seal.

b. Groove the pipe in accordance with the Victaulic Standard or AGS grooving specifications as applicable. NOTE: PIPE MUST BE ROLL GROOVED WITH THE APPROPRIATE VICTAULIC AGS ROLL SETS FOR 14" AND LARGER. REFER TO THE INSTRUCTIONS FOR THE SPECIFIC COUPLING FOR ADDITIONAL INFORMATION.

c. Clean the outside surface of the pipe, from the groove to the pipe end, to remove all oil, grease, loose paint, and dirt.

4. Couplings and Gaskets

a. Do not disassemble the coupling if Style 177 and 107H Couplings are being used; these are installation ready.

b. The outside surface of the pipe/ mating component, between the groove and the pipe/mating component end, must be smooth and free from indentations, projections (including weld seams), and roll marks. All oil, grease, loose paint, dirt, and cutting particles must be removed. Measurements taken across grooved pipe/mating component ends must not exceed the maximum allowable flare diameter. Refer to current manufacturer grooving specifications for the maximum allowable flare diameter.

c. Check the gasket to make sure it is suitable for the intended service. The color code identifies the gasket grade per the manufacturer.

d. Apply a thin coat of Victaulic Lubricant or silicone lubricant only to the sealing lips of the gasket interior. NOTE: The gasket exterior is supplied with a factory-applied lubricant, so there is no

need to remove the gasket from the housings to apply additional lubricant to the exterior surface.

e. Never leave a Coupling partially assembled. A partially assembled Coupling poses a drop hazard.

f. Assemble the joint by inserting the grooved end of a pipe/mating component into each opening of the coupling. The ends of the grooved pipe/mating components must be inserted into the coupling until contact with the center leg of the gasket occurs. A visual check is required to ensure the coupling keys align with the grooves in the pipe mating components. NOTE: The coupling may be rotated to ensure the gasket is seated properly.

g. When assembling couplings onto end caps, take additional care to ensure the end cap is seated fully against the center leg of the gasket.

h. Tighten the nuts evenly by alternating sides until metal to metal contact occurs at the bolt pads. The middle section of the bolt pad mating surfaces must be in full metal-to-metal contact to ensure a properly assembled joint. Make sure the housings' keys engage the grooves completely during tightening.

i. Grooved Joints: Cut groove ends of ductile-iron pipe, roll groove ends of steel pipe, and roll groove ends of copper tube, and assemble grooved ends of pipes, grooved-end fittings, and grooved-end-piping couplings according to AWWA C606 and manufacturers guidelines and recommendations. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be developed and supplied by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. A factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.16 DISINFECTION OF WATER SYSTEMS

A. General

1. All water piping systems shall be thoroughly disinfected with a solution containing not less than 50 parts per million of available chlorine by this Plumbing Subcontractor.

2. The chlorinating material shall be either liquid chlorine or sodium hypochlorite solution.

B. This work is to be supervised by the Owner's representative and performed by an owner approved chemical testing laboratory and results sent to the Architect/Engineer or his representative for verification. All costs shall be borne by this Plumbing Subcontractor.

C. The testing laboratory shall submit a summary of the test procedure to the Owner for approval prior to any work being performed. All work to be in accordance with the Owner's requirements. This Plumbing Subcontractor shall provide any and all valves, pipe and connections required to disinfect the water supply system totally or in part as required. Provide isolating valves and draw-off valves for proper containment, phasing and flushing.

D. Procedure

1. The water systems shall be tested and thoroughly flushed prior to chlorination. The procedure shall be per one of the following two options:

   a. The system, or part thereof, shall be filled with a water and chlorine solution which contains 50 parts per million of available chlorine; and the same shall then be allowed to stand six hours before the system, or part thereof, is flushed and returned to service.

   b. The system, or part thereof, shall be filled with a solution which contains 100 parts per million of available chlorine; and the same shall then be allowed to stand two hours before the system, or part thereof, is flushed and returned to service.

2. The chlorine shall be introduced at the point of the building water service for interior piping. During which period all valves and faucets shall be opened and closed several times with the chlorine drawn to all points in the system. After disinfection, the solution shall be flushed from the system with potable water until the residual chlorine content is not greater than 0.2 parts per million. Prior to any further testing procedures, the Engineer and the Owner shall review all draw-off valve locations and chlorine introduction locations.

3. The Plumbing Subcontractor is to allow ample time for the chlorination of the water systems and is to plan the chlorination just prior to occupancy if possible. If the system is to sit dormant for any extended period of time prior to occupancy, the contractor is to flow water to all points in the building to completely flush the systems prior to occupancy. A full three days notice will be given the Owner and Engineer prior to the start of disinfection.

E. Tests

1. The Owner's representative shall select two locations on each floor of each building for a chlorine concentration test. The Owner's representative shall select three locations on each floor for a chlorine residual, a coliform bacteria and total plate count bacteria tests. The laboratory report shall include sample locations, chlorine concentration, chlorine residual, coliform bacteria count and, after flushing, total plate count bacteria tests.

2. Acceptable limits for total plate count shall be 300 per 100 ml sample. Acceptable levels of chlorine residual shall be .2 PPM.

3. If these parameters are not met, continued flushing of the water systems shall be required until they are met.

4. Full Owner acceptance of the water systems shall not be given until these parameters are met, documented and submitted by the Testing Laboratory selected.

3.17 PLUMBING CONNECTED EQUIPMENT

A. Furnish and install domestic hot and cold water piping and natural gas, piping as required including pipe stands and trim and all final connections to plumbing connected equipment furnished by others. Roughing for this equipment shall be as indicated on the drawings.

B. Furnish and install shutoff valves and unions at each piece of equipment. Obtain exact roughing in dimensions from manufacturers of all service locations before connecting to or roughing for equipment.

C. Furnish and install backflow preventers, pressure reducing valves, solenoid valves, check valves, strainers and vacuum breakers as required.

D. Sinks and equipment connected to by this Contractor but furnished and set under another section of the Specifications shall be identified on the drawings by “P” number and designated as such. Coordinate casework and sink units with Section 11200.

3.18 VALVE TAGS AND CHARTS

A. Provide neat circular brass valve tags of at least 1 ½" in diameter, attached with brass hook to each valve stem or handle as determined by Architect. Stamp on these valve tags, in letters as large as practical, the number of the valve and the service, such as "CW", for cold water. The numbers of each service shall be consecutive. Obtain approval of Architect prior to installation.

B. All valves on equipment shall be numbered by 3" red metal discs with 2" high white numbers secured to stem of valves by means of brass hooks or small link brass chain.

C. These numbers shall correspond to numbers indicated for valves on the Record Drawings and on (2) printed detailed lists. These printed lists shall state the numbers and locations of each valve and the equipment or system which it controls and other necessary information such as requiring the opening or closing of another valve or valves when any one valve is to be opened and closed.

D. These printed lists shall be prepared in form to meet approval of the Architect and shall be framed under glass. Provide valve lists in booklet form also and submit (8) copies to the Architects.

E. Tag numbers shall correspond to numbers indicated for valves on the record drawings and on three printed detailed lists. These printed lists shall state the number and location of each valve and the area which it controls and other necessary information, such as requiring the opening or closing of another valve or valves, when anyone valve is to be opened or closed.

F. Valve charts shall include Plumbing Subcontractor name and phone number, date of chart, name and telephone number of Architectural Firm, Consulting Mechanical Engineering Firm and the Owner's Representative.

3.19 NATURAL GAS SYSTEM

A. Connect to new service where indicated with an approved shutoff valve and extend to the required points throughout the buildings. Obtain permits and defray all costs incidental to the interior gas piping. Furnish and install all piping, stop valves and connections to all equipment and outlets requiring gas within the building.

B. A suitable drip or condensate pocket shall be installed at bottom of risers.

C. Gas piping and safety devices shall conform to the requirements of the NFPA Standard No. 54 and shall be subject to inspection and approval of the State Gas Regulatory Board.

D. Special Note: Furnish and install aluminum check valves in all gas pipes that enter rooms where compressed air is also installed or when both compressed air and gas piping connect to the same piece of equipment. This is required in all laboratories and areas where gas and air are present together.

E. Provide a gas cock valve at each branch runout from main or riser serving gas outlets.

F. All piping shall be securely fastened separately hung and shall not support any other weight or piping. Piping dropping in concrete block walls shall be factory wrapped for corrosion protection.

G. Gas valves or cocks shall not be concealed and shall be readily accessible for inspection and repair. All welded piping shall conform to the latest requirements of the National Fuel Gas Code.

H. Natural gas piping (exposed, outside the building) shall be painted gray with the paint as listed below. Elevated pressure (14" water column and greater) natural gas piping shall be painted yellow whether it is outside or within the building with the paint as listed below:

1. Benjamin Moore Super Spec HP Epoxy Mastic P45, self priming, high build, impact resistant, interior or exterior application.

2. 3 coats, minimum dry film thickness of 12.0 mils.

I. Immediately adjacent to the point the gas line enters the building, furnish and install a full line size thermally activated automatic shut-off valve inside the building.

J. Purging shall be per NFPA 54 and as follows:

1. Scope:

a. The purging of piping systems shall be in accordance with the provisions of 8.3.1.1 through 8.3.1.4 where the piping system meets either of the following:

1) The design operating gas pressure is greater than 2 psig (14 kPa).

2) The piping being purged contains one or more sections of pipe or tubing greater than 2 in. and exceeding the lengths in NFPA 54 table 8.3.1.1 as follows:

Nominal Pipe	Length of Pipe

Size	
2 ½”	Greater than 50’
3”	Greater than 30’
4”	Greater than 15’

3) Where existing gas piping is opened, the section that is opened shall be isolated from the gas supply and the line pressure vented to the exterior per NFPA 54, the residual fuel gas in the piping shall be displaced with an inert gas.

b. Piping Systems Allowed to Be Purged Indoors or Outdoors.

1) The purging of piping systems shall be in accordance with the provisions of 8.3.2.1 where the piping system meets the following:

a) The design operating pressure is 2 psig (14 kPa) or less AND the piping system being purged is constructed entirely from pipe or tubing of 2-in. nominal size or smaller, or larger pipe or tubing with lengths shorter than specified herein before.

2. Purging Procedure

a. The piping system shall be purged in accordance with one or more of the following:

1) The piping shall be purged with fuel gas and shall discharge to the outdoors.

2) The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through an appliance burner not located in a combustion chamber. Such burner shall be provided with a continuous source of ignition.

3) The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through a burner that has a continuous source of ignition and that is designed for such purpose.

4) The piping shall be purged with fuel gas that is discharged to the indoors or outdoors, and the point of discharge shall be monitored with a listed combustible gas detector. Purging shall be stopped when fuel gas is detected.

3. Combustible Gas Detector

a. The combustible gas detector used during purging operations shall be listed and shall be calibrated or tested in accordance with the manufacturer's instructions and recommended schedule. The combustible gas detector used for pipe discharge monitoring shall indicate the presence of fuel gas.

4. Purging Appliances and Equipment.

a. After the piping system has been placed in operation, appliances and equipment shall be purged before being placed into operation.

K. Placing in Operation

1. Where gas piping containing air is placed in operation, the air in the piping shall first be displaced with an inert gas. The inert gas shall then be displaced with fuel gas in accordance with NFPA 54.

2. Outdoor Discharge of Purged Gases.

a. The open end of a piping system being pressure vented or purged shall discharge directly to an outdoor location. Purging operations shall comply with all of the following requirements:

1) The point of discharge shall be controlled with a shutoff valve.

2) The point of discharge shall be located at least 10 ft (3 m) from sources of ignition, at least 10 ft (3 m) from building openings and at least 25 ft (7.6 m) from mechanical air intake openings.

3) During discharge, the open point of discharge shall be continuously attended and monitored with a combustible gas indicator that complies with

4) Purging operations introducing fuel gas shall be stopped when 90% fuel gas by volume is detected within the pipe.

5) Persons not involved in the purging operations shall be evacuated from all areas within 10 ft (3 m) of the point of discharge.

3. Combustible Gas Indicator.

a. The combustible gas indicator used during purging operations shall be listed and shall be calibrated in accordance with the manufacturer's instructions and recommended schedule. The combustible gas indicator used for pipe discharge monitoring shall numerically display a volume scale from 0% to 100% with a resolution of not greater than 1% increments.

3.20 PLUMBING SYSTEMS ACCEPTANCE PROCEDURE

A. Performance Testing

1. The Plumbing Subcontractor shall coordinate with other subcontractors, and work together to demonstrate each system completely to the Owner, proving that all systems work installed and comply with the design concept, shop drawing and sequence of control. The subcontractor shall submit, by system, a performance test method and format that indicates the system, the point descriptors for all systems, field values, BAS values, occurrence values, manual automatic controls, status values, etc., for approval.

2. The subcontractor shall assist and demonstrate, by witness tests, education programs, inspection, the functioning of the plumbing systems as part of the complete Building Acceptance Procedure. Refer of General Conditions for additional requirements.

3. A separate binder shall be maintained by the subcontractor containing, by system, all punch list items, performance test format and trend logs relative to testing.

4. The subcontractor shall notify the Owner in writing that each system is complete and ready for testing. If it is found that the systems are incomplete, the Plumbing Subcontractor shall reimburse the Owner for additional time, expenses and material required to complete testing of each system.

5. Upon completion of the performance test of each system, the Owner , in writing, shall submit his recommendation regarding acceptance so that beneficial use may be determined.

B. Owner's Acceptance of Test Procedure

1. Submittal data relevant to Performance Characteristics, functions, limits, sequences, interlocks, power fail-restart, and associated parameters and other pertinent information for the operation system and data base shall be forwarded from the Plumbing Subcontractor to the Owner's authorized representative and Engineer's representative.

2. Any deficiency identified during demonstration shall be noted as a punch list item, but progress of demonstration shall not be halted to correct the deficiencies.

3. Problems which occur within approved hardware or software shall be corrected in an appropriate fashion under guarantee. Any such occurrence shall not void previous approval; however, the Plumbing Subcontractor shall be responsible to attend and to remedy such items within reasonable amount of time. Appropriate logs, schedules and reports shall be maintained to reflect these items and their redress.

3.21 WATER SERVICE INSTALLATION

A. This Plumbing Subcontractor shall comply with all the rules, codes, ordinances, regulations and requirements of all legally constituted authorities having jurisdiction over the whole or any part of the work herein specified. These requirements are minimum criteria and no reductions permitted by code will be allowed without written permission of the Architect.

B. This work shall include the furnishing and installation of all labor, materials and equipment except excavation and backfill necessary for the complete installation of all work in accordance with the requirements of Berlin, Meriden, and Wallingford and Connecticut Departments of Public Works.

C. Excavation and backfill of the trenches for the pipe and hydrants shall be performed under the work of Division 31 - EARTHWORK.

It shall be the responsibility of this Plumbing Subcontractor Contractor to insure that bedding, depth, width, bottom of trench, etc., is suitable for the proper installation of the work.

D. Excavation: The trench for the pipe shall be excavated to the required line and grade and of sufficient width to permit thorough tamping of the fill material under the haunches and around the pipe. Soft or unsuitable material encountered below the normal bedding line of the pipe shall be removed as directed, replaced with graded gravel and thoroughly compacted. Graded gravel shall be installed to level the trench and shall be placed to a minimum depth of six (6) inch depth

below the pipe. The bottom of the trench shall be shaped to conform to the curvature of the pipe. This bed shall also be excavated to accommodate the bells of pipes. If any cross pipes, conduits, drains or other unforeseen obstacles are encountered in the excavation, the grade of the bottom of the trench may be raised or lowered during the excavation operation, as directed by the Architect. Use concrete or other approved support under the existing pipes passing through the excavation where said pipe would normally be supported by backfilled earth. Where concrete obstructions, ledge or boulder formations are encountered, it shall be removed to a line six inches (6") below the bottom of the outside of the pipe barrel. No part of any rock remaining in the trench shall come within six inches (6") of any portion of the pipe.

E. Bedding Pipe: The pipe shall be laid true to the specified lines and grades. Material placed around and under the pipe shall be graded gravel free of stones larger than two inches (2") in diameter. The pipe shall be bedded on a graded gravel foundation of uniform density carefully shaped to fit the lower part of the pipe exterior for at least fifty percent (50%) of its overall height. No blocking of any kind shall be permitted.

F. Assembly: After pipes have been bedded, joining and assembly shall be in accordance with the procedures hereinafter specified.

G. Backfilling: After pipe and joints have been inspected and approved by the Architect, the trench shall be backfilled.

1. Backfill above centerline of pipe to a point 12" above top of pipe shall be graded gravel, free of stones larger than two (2) inches and tamped by hand with a flat tamper, placed in six (6) inch layers.

2. Backfill material twelve inches (12") above pipe may be material that was excavated for trench, provided that fill is free from stones larger than six inch (6") diameter, clay, dry or frozen lumps and foreign objects.

H. Tie cards shall be furnished to the town with “As-Built” measurements of the existing water service, with distances from main to curb stop, curb stop to house, and from each corner of house to curb stop. A metallic identification tape shall be buried one foot below finished grade along the length of the service feed.

3.22 EXTERIOR WATER PIPING

A. All outside underground water piping shall have a minimum cover of five feet.

B. The water service shall be laid and maintained to the required lines and grades.

C. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted, the amount of deflection allowed shall not exceed manufacturer's recommendations. No pipe shall be laid in water or when trench conditions are unsuitable.

D. All joints shall be left fully exposed in view, unless otherwise ordered by the Architect, until test has been completed and approved.

E. Care shall be taken in loading, transporting and unloading to prevent injury to the pipes or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Architect.

F. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by this SECTION 02660 330000 Subcontractor at his own expense. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until used in the completed work, and when laid, shall conform to the lines and grades required.

G. Ductile iron pipe and fittings shall be installed in accordance with the requirements of AWWA Standard Specification C600, except as otherwise provided herein. A firm, even bearing throughout the length of the pipe shall be constructed by tamping selected material at the sides of the pipe, up to the spring line. BLOCKING WILL NOT BE PERMITTED. Pipe shall be laid at 5'0" minimum cover.

H. All pipe shall be sound and clean before laying. When laying is not in progress, including lunch time, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved in laying. The deflection at joints shall not proceed that recommended by the manufacturer. Fittings, in addition to those shown on the Plans, shall be provided if required, in crossing utilities which may be encountered upon opening the trench. Solid sleeves shall be used only where approved by the Architect.

I. When cutting of pipe is required, the cutting shall be done by machine leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a Tyton bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.

J. Pipes, valves, hydrants and fittings shall be inspected for damage when received and shall be inspected prior to installation. Bolted joints shall be checked for proper torquing of bolts. Pipe, valves, hydrants and fittings shall be clean inside.

When work is stopped, open ends shall be plugged to prevent stones and foreign materials from entering.

K. All pipe, fittings, valves and hydrants shall be carefully lowered into the trench with suitable equipment. They shall be carefully examined for cracks or other defects while suspended above the trench immediately before installation. Plain ends shall be inspected with special attention as these ends are the most susceptible to damage. Under no circumstances shall water main materials be dropped or dumped. Pipe shall not be rolled or skidded against other pipe materials.

L. Pipes shall bear throughout their full length and shall not be supported by the bell ends only or by blocks.

M. Joints shall be assembled by persons familiar with the particular materials being used and in accordance with the manufacturer's instructions and specifications.

N. All bolted joint accessories shall be cleaned and thoroughly coated with asphalt or other corrosion-retarding material after installation.

O. All elbows and bends and all plugs at blanked openings shall be securely braced and clamped in approved manner, as required by Pamphlet No. 24 of the NFPA and the pipe manufacturer.

P. Clamps shall be 1/2" x 2" for pipe 4" in diameter; 5/8" x 2 1/2" for pipe 8" and 5/8" x 3" for pipe 12". Bolt holes shall be 1/16" diameter larger than bolts. Rods shall be 3/4" diameter for pipes 4", 6" and 8" diameter. Washers may be cast iron or steel, round, or square. Dimensions for cast iron washers are 1/2" x 3" for pipe 4", 6", 8" and 12" diameter. Holes shall be 1/8" larger than the rods.

Q. Straps shall be 5/8 in. (15.9 mm) thick and 2-1/2 in. (63.5 mm) wide for pipe 4, 6 and 8 in.; 5/8 in. (15.9 mm) thick and 3 in. (76.2 mm) wide for pipe 12 in. Rod holes shall be 1/16 in. (1.6 mm) diameter larger than rods.

R. Material used for clamps, rods, rod couplings or turnbuckles, bolts, washers, anchor straps, and plug straps shall be of material having physical and chemical characteristics such that its deterioration under stress can be predicted with reliability.

S. After installation, rods, nuts, bolts, washers, clamps and other restraining devices except thrust blocks shall be cleaned and thoroughly coated with a bituminous or other acceptable corrosion-retarding material.

T. Underground mains and lead-in connections to building shall be flushed thoroughly before connection is made to building piping in order to remove

foreign materials which may have entered the underground main during the course of the installation or which may have been present in existing piping. The minimum flow rate for domestic water service shall be not less than the rate necessary to obtain 10 feet per second velocity. For all systems, the flushing operations shall be continued for a sufficient time to ensure thorough cleaning. When planning the flushing operations, consideration shall be given to disposal of the water issuing from the test outlets.

U. This Plumbing Subcontractor shall submit for approval a proposed flushing plan and schedule, including time of day, duration of flushing, disposal point of water, manpower to be used and equipment needed, to the Architect and the Water Department at least thirty (30) days in advance of the proposed flushing.

V. No flushing will be allowed until the Architect and Water Department have approved this plan and schedule. This Plumbing Subcontractor shall perform the flushing at times and dates and manner required by the Water Department.

3.23 JOINTING DUCTILE IRON PIPE (PUSH-ON TYPE)

A. Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined, and pushed home with a jack or by other approved means. After joining the pipe, a metal feeler shall be used to make certain the rubber gasket is correctly located.

3.24 JOINTING MECHANICAL PIPE AND FITTINGS

A. The method of jointing pipe, valves, fittings, and where designated, shall be in accordance with the "Notes on Method of Installation" under ANSI Specification A21.11 and the instructions of the manufacturer. To assemble the joints in the field, this Plumbing Subcontractor shall thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torques. Under no conditions shall extension wrenches, or pipe over handle, or ordinary wrenches be used to secure greater leverage.

3.25 EXTERIOR WATER PIPING (BURIED) TESTS AND TESTING PROCEDURES

A. General

1. All labor, materials, instruments, devices and power required for testing shall be furnished by the Plumbing Subcontractor. All tests shall be performed in the presence and to the satisfaction of the Architect, the

Danvers Water Department and such other parties as may have legal jurisdiction.

2. Repair, or if directed by the Architect, replace all defective work with new work without extra charge to the Contract. Repeat tests as directed until all work is proven to meet the requirements specified herein.

3. Restore to its finished condition, any work damaged or disturbed by tests.

4. Perform all tests herein specified and all other tests which may be required by any and all authorities or agencies to whose requirements this work is to conform.

5. This Plumbing Subcontractor shall notify the Architect and all inspectors having jurisdiction, a minimum of 48 hours in advance of making any required tests, so that arrangements may be made for their presence to witness his scheduled tests.

B. The trench shall be backfilled between joints before testing to prevent movement of pipe.

C. All new piping shall be tested hydrostatically at not less than 200 psi (13.8 bars).

D. Tests for leakage shall be conducted on all portions of the pipe lines. Prior to testing, all sections of the pipe lines, including hydrants, the entire lengths of pipelines shall be flushed clean and free from all dirt and foreign material. All air shall be released and the pipe lines completely filled with water. After allowing 3 days for absorption, the internal pressure shall be built up by use of a force pump to the 200 psi. Filling of the lines shall be done as slowly as practicable so as not to cause dirty water and serious pressure drop within the municipal system.

E. Means shall be made to vent air from the mains during the filling process. After the mains have been filled, the controlling gate valves shall be closed and the new mains kept isolated from the existing system. The new mains shall be held at static pressure for at least 3 days before test is begun.

F. The piping shall be filled and pressurized to 200 psi after the 3 day period and this shall be held for 15 minutes. Then the pressure shall be dropped to the normal working pressure and then built back up to 200 psi and held for 2 hours.

G. The amount of leakage in piping shall be measured at the specified test pressure by measuring with a meter or if allowed by the Water Department pumping from a calibrated container.

H. The maximum allowable rate of leakage shall be calculated by one of the following methods. The method which results in the minimum leakage shall be the maximum allowable rate.

1. The amount of leakage at the joints shall not exceed two quarts per hour(1.89 L/h) per 100 gaskets or joints irrespective of pipe diameter. The amount of allowable leakage specified may be increased by one fluid ounce per inch valve diameter per hour (30 ml/25/mm/h) for each metal seated valve isolating the test section. If dry barrel hydrants are tested with the main valve open, so the hydrants are under pressure, an additional five ounces per minute (150 ml/min) leakage is permitted for each hydrant, or;

2. The maximum allowable amount of inflow of water to maintain the required test pressure shall not exceed 12 gallons per inch of internal diameter of the pipe lines per mile of pipes per day.

I. The test pressures shall be maintained for the full period of tests. (One hour)

J. In case the specified rate of leakage is exceeded, the leaks shall be removed and replaced by this Plumbing Subcontractor and the pipe line retested, repeatedly if necessary, at no additional expense to the Owner, until the required conditions are met. The tests shall be continued for a period of at least one hour after all leaks have been stopped and all corrective work has been satisfactorily completed and after the maximum rate of inflow of water into the pipe line as specified above has not been exceeded.

K. If, in the judgement of the Owner, it is impracticable to follow any of the foregoing procedures exactly for any reason, modifications in the procedures shall be made as approved, but in any event this Plumbing Subcontractor shall be responsible for the ultimate tightness of all pipelines within the respective leakage requirements specified herein. Any modifications to the procedures, as directed, shall be performed by this Plumbing Subcontractor at no additional expense to the Owner. All hydrants shall be pressure tested in the open position at the same time as the main line.

L. Tests shall be made by the Plumbing Subcontractor in the presence of Architect and Water Department.

M. All control valves shall be fully closed and opened under system water pressure to ensure proper operation.

3.26 FLUSHING AND DISINFECTION

A. This Plumbing Subcontractor shall furnish all plant, labor, material and equipment to flush and disinfect the incoming water service in accordance with the procedures outlined in the AWWA Standard for Disinfecting Water Mains Designation C 601-68.

B. Care shall be exercised during the disinfecting period not to contaminate any water in existing lines. The water used in disinfecting and flushing shall be disposed of in an acceptable manner.

C. Disinfection shall take place after the pressure testing procedure. Prior to disinfecting, the new line shall be flushed to remove all dirt and debris. Flushing shall include both intermediate and end hydrants on a run. Hydrants shall be flushed at sufficient volume to move any dirt in the pipe. Samples shall be taken during flushing and analyzed for sediment.

D. After flushing, the new line shall be isolated from existing water lines, and a chlorine solution introduced into the main. Chlorine shall be introduced through a hydrant or special tap in the main. During the introduction, the final hydrant shall be bled to ensure that the chlorine solution travels the entire length of the line. A test kit shall be used to verify that a suitable concentration exists.

E. Chlorine solutions shall be derived from calcium hypo chlorinate or sodium hypo chlorite. Sufficient chlorine shall be added to produce a 50 mg/l residual in the main.

F. Chlorine shall be allowed to remain in the main for a minimum of twenty-four hours. A chlorine residual of at least 25 mg/l shall be maintained at the end of this 24 hours. Retain this water in the piping for 72 hours. At the end of the 72 hours, make arrangements with the Water Department to dispose of the test water. During this period, all valves and hydrant valves shall be operated at least once. After disinfection, the line shall be flushed clean of all chlorine down to the normal residual level for the system. Samples shall be taken and analyzed for bacterial quality. A minimum of two samples shall be taken at different points. Additional samples may be required based on the length of line. Samples shall be analyzed by a State Certified Laboratory, subject to the approval of the Architect. Sampling shall be at this Plumbing Subcontractor's expense.

G. Any sample which results in a positive coliform count shall be repeated until three successive zero counts are recorded. If a subsequent coliform count is recorded, then the flushing and chlorination procedure shall be repeated. The line shall not be placed in service until three successive zero coliform counts are recorded.

H. A full report of the disinfection results shall be furnished to the Architect for verification prior to acceptance of system.

3.27 OFFSITE WORK AND COORDINATION WITH EXISTING UTILITIES

A. Special attention shall be given to the protection of, and coordination with, existing off-site utilities. Plumbing Subcontractor shall contact the Local Public Works Department and the Gas Company, as well as "DIG-SAFE" to identify and locate these service connections prior to beginning any work.

B. All utility work, both on and off site, shall comply with Local Public Works Department requirements and standards. Submit all equipment, materials and methods to the Public Works Department for approval prior to submitting to the Architect, and prior to purchasing any equipment or materials.

3.28 TERMINATION OF PIPING WITHIN BUILDING

A. Water service piping shall be terminated within the building with a flanged end piece, as detailed on the drawings. The flange shall be set square, level and plumb. Uni-flanges or similar devices are prohibited.

B. Piping passing through foundation walls and floor slabs shall pass through these surfaces square to the surfaces and plumb to the building.

C. Service entrances into the building will be restrained as shown on the details on the drawings, for the developed thrust generated from the water pressure present

END OF SECTION OF 220000

SECTION 230500 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 – GENERAL

1.01 PROVISIONS INCLUDED

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Examine all other Sections of the specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

D. Coordinate work with that of all other Trades affecting, or affected by work of this Section. Cooperate with such Trades to ensure the steady progress of all work under the Contract.

1.02 DEFINITIONS

A. Words in the singular shall also mean and include the plural, wherever the context so indicates and words in the plural shall mean the singular, wherever the context so indicates.

B. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.

C. Wherever the term "provide" is used in the specifications it will mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.

D. Wherever the term "material" is used in the specifications it will mean any product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.

E. The terms "approved", or "approval" shall mean the written approval of the Architect.

F. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.

G. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed" and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect. The terms "approved", "acceptable", "satisfactory" and similar words shall mean approved by, acceptable or satisfactory to the Architect. The terms "necessary", "reasonable", "proper", "correct" and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.

H. "Piping" includes in addition to pipe or mains, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

I. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.

J. "Exposed" means not installed underground or "concealed" as defined above.

K. "Invert Elevation" means the elevation of the inside bottom of the pipe.

L. "HVAC, Plumbing, and/or Fire Protection Contractor" shall refer to the Contractor or his Subcontractors responsible for furnishing and installation of all work indicated on the HVAC, Plumbing, and/or Fire Protection drawings and specifications, as applicable and or referenced to each Trade in the Architectural and/or Structural documents.

M. "Mechanical Contractor" shall refer to the Fire Protection, Plumbing, HVAC and ATC Contractors, as applicable.

N. "Architect" shall refer to the Architect "Michael Baker Jr., Inc." and Engineer "Hatch Mott MacDonald" and Owner “State of Connecticut, Department of Trasnportation.

O. "Owner" shall refer to the designated representatives of the Project Owner.

P. "General Contractor" shall refer to the Contractor(s) performing work under other sections of the Contract Specifications.

Q. "Commissioning Agent (CA)" shall refer to the party employed by the Owner to witness the demonstration of all systems according to the commissioning plan. Refer to Division 50.

1.03 CODES, STANDARDS AND REFERENCES

A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local and State Ordinances, Industry Standards and Utility Company Regulations, latest editions.

B. In case of difference between Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations and the Contract Documents, the Mechanical Contractor, as applicable, shall promptly notify the Architect in writing of any such difference.

C. In case of conflict between the Contract Documents and the requirements of any Code or Authorities having jurisdiction, the most stringent requirements of the aforementioned shall govern for budgetary purposes. However, no work will proceed until the Architect determines the correct method of installation.

D. Should any Contractor, as applicable, perform any work that does not comply with the requirements of the applicable Building Codes, State Laws, Local Ordinances, Industry Standards and Utility Company Regulations, he shall bear all costs arising in correcting the deficiencies, as approved by the Architect.

E. Applicable Codes and Standards shall include all State Laws, Local Ordinances, Utility Company Regulations and the applicable requirements of the following accepted Codes and Standards, without limiting the number, as follows:

1. National Electrical Code-2005 (NEC)

2. Environmental Protection Agency (EPA)

3. Connecticut -- Environmental Air Quality Protection Agency

4. Connecticut Building Code/IBC-2003, including all adopted Connecticut Supplements

5. International Mechanical Code-2003 including all adopted Connecticut Supplements

6. International Energy Conservation Code-2009 including all adopted Connecticut Supplements

7. Connecticut - Fire Prevention Regulations and Elevator Regulations

8. Local Ordinances, Regulations of the Local Building Department and Fire Department

9. Recommendations of the National Fire Protection Association (NFPA), latest applicable edition adopted, in general and in particular:

    a. Life Safety, NFPA 101

    b. HVAC, NFPA 90A, 90B

10. Recommendations of ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers), including:

    a. ANSI/ASHRAE 90.1 and 90.2 – Energy Standard for Buildings

    b. ANSI/ASHRAE 62.1 and 62.2 – Ventilation for Acceptable Indoor Air Quality

    c. ANSI/ASHRAE 15-Safety Code for Mechanical Refrigeration

    d. ANSI/ASHRAE 110-Method of Testing Performance of Laboratory Fume Hoods

    e. ANSI/ASHRAE 55-Thermal Environmental Conditions for Human Occupancy

F. In these specifications, references made to the following Industry Standards and Code Bodies are intended to indicate the accepted volume or publication of the Standard. All equipment, materials and details of installation shall comply with the requirements and latest revisions of the following Bodies, as applicable:

1.	AMCA	Air Moving and Conditioning Association
2.	ANSI	American National Standards Institute
3.	ARI	American Refrigeration Institute
4.	ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
5.	ASME	American Society of Mechanical Engineers
6.	ASTM	American Society of Testing Materials
7.	AWS	American Welding Society

8.	CS	Commercial Standards, U.S. Department of Commerce
9.	FM	Factory Mutual
10.	FS	Federal Specification, U.S. Government
11.	MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
12.	NEMA	National Electrical Manufacturers Association
13.	SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
14.	UL	Underwriters' Laboratories, Inc.

G. Each Contractor for the work under his charge, shall give all necessary notices, obtain and pay for all permits, pay all governmental taxes, fees and other costs in connection with his work; file for necessary approvals with the jurisdiction under which the work is to be performed. Each Contractor shall obtain all required Certificates of Inspection for his work and deliver same to the Architect before request for acceptance of his portion of work and before final payment is made.

H. All equipment shall be installed per manufacturer’s recommendations and requirements. The Contractor shall notify the Engineer in writing when they intend to deviate from manufacturer's installation guidelines. The Engineer shall advise if the installation is acceptable prior to installation.

1.04 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Submit detailed shop drawings or brochures for approval of equipment and material proposed to be used on this project. Furnish the number of copies required by General Conditions.

C. Documents submitted shall show the following:

1. Principal dimensions and details of construction.

2. Operating and maintenance clearances.

3. Weights of principal parts and total weights with information required for the design of supports and foundations.

4. Sizes and location of piping and connections.

5. Performance data, including pump and fan curves; sound data including sound power dB levels in 1/3 octave bands.

6. Data on electric motors, including brake horsepower of driven equipment, nameplate ratings and classes, sound data, starting and running full load currents, required starter size and recommended overload heater ratings.

7. Approval stamp of Underwriters' and other authorities having jurisdiction of Contract Drawings requiring such approval.

8. Certified performance guarantees.

9. Calculations and details for refrigeration for field assembled systems including description of specialties and pressure drops, layout of piping with lengths fittings, and refrigerant specialties, and capacity curves for evaporator and compressor showing balance points.

10. Minimum scale for sheet metal plans and piping plans shall be ¼ inch equal 1 foot.

D. Submit brochures that contain only that information which is relative to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless irrelevant information is marked out and relevant material is clearly marked.

E. Specifications Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with the specifications.

2. The statement of compliance shall consist of a list of all paragraphs (line by line).

3. Where the proposed system complies fully, such shall be indicated by placing the word "comply" opposite the paragraph number.

4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.

5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.

6. Submissions which do not include a point by point statement of compliance as specified shall be disqualified.

1.05 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.06 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.07 GUARANTEE

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Manufacturers shall provide their standard guarantees for work under this Contract, unless specified otherwise. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and GC may have by Law or by other provisions of the Contract Documents. In any case, such guarantees and warranties shall commence when the Owner accepts the various systems, as applicable and as determined by the Architect. The guarantees and warranties will remain in effect for a minimum period of (1) year thereafter except where longer periods are specifically stated and specified.

C. All materials, items of equipment and workmanship furnished under HVAC, shall carry the warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Contractor responsible, including all other damage done to areas, materials and other systems resulting from this failure.

D. Each Contractor shall guarantee that all elements of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated on the drawings.

E. Upon receipt of notice from the Owner of failure of any part of the systems or equipment during the guarantee period, the affected part or parts shall be replaced by the responsible Contractor.

F. Each Contractor shall furnish, before the final payment is made, a written guarantee covering the above requirements.

1.08 COMMISSIONING

A. The TBA Contractor must also include sufficient man-hours within their bids, for their participation with the Commissioning Team and the rebalancing/readjusting/resetting all device setpoints, as required. For additional work, refer to Division 50.

1.09 THE CONTRACTOR

A. Each Contractor shall base his bid on site examinations performed by him. This requirement is mandatory. Each Contractor shall visit the proposed site where work is scheduled to be performed and ascertain for himself the amount of work required to fulfill the intent of his Contract and the complexity of the installation. Each Contractor shall not hold the Architect, his Consultants, agents or employees responsible for or bound by, any schedule, estimate or for any plan thereof. Each Contractor shall study all Contract Documents (HVAC, Plumbing, Electrical, Communications, Architectural, Structural), etc., included under each Contract, to determine exactly the extent of work to be provided under each Section, and in installing new equipment and systems and coordinating the work with the other Trades and existing conditions.

B. Each Contractor shall faithfully execute his work according to the terms and conditions of the Contract and specifications and shall take all responsibility for and bear all losses resulting to him in the execution of his work.

C. Each Contractor shall be responsible for the location and performance of work provided under his Contract as indicated on the Contract Documents. All parties employed directly or indirectly by each Contractor shall perform their work according to all the conditions as set forth in these specifications.

D. Each Contractor shall furnish all materials and perform all work in accordance with the project specifications and any supplementary documents provided by the Architect. The work shall include every item shown on the drawings and/or required by the specifications as interpreted by the Architect. All work and materials furnished and installed shall be new and of the best quality and workmanship. Each Contractor shall cooperate with the Architect so that no error or discrepancy in the Contract Documents shall cause defective materials to be used or poor workmanship to be performed.

1.10 COORDINATION OF WORK

A. Each Contractor shall compare his drawings and specifications with those of other Trades and report any discrepancies between them to the Architect and obtain from the Architect written instructions for changes necessary in the mechanical or electrical work, to ensure that all work is installed in coordination and

cooperation with other Trades installing interrelated work. Before installation, each Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect. All changes required in the work of each Contractor caused by his negligence, shall be corrected by him at his own expense, to the Architect's satisfaction.

B. Locations of piping, ductwork, conduits and equipment shall be adjusted to accommodate the new work with interferences anticipated and encountered during installation. Each Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination drawings will have to be completed to verify dimensions and characteristics of the various systems' installations.

C. Lines which pitch shall have the right-of-way over those which do not pitch. For example, waste piping shall normally have the right-of-way. Lines whose elevations cannot be changed shall have the right-of-way over lines whose elevations can be changed.

D. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Each Contractor shall provide manual air vents and drains as required for his work to affect these offsets, transitions and changes in direction, as applicable.

E. All work shall be installed in a way to permit removal (without damage to other parts) of coils, filters, control appurtenances, fan shafts and wheels, filters, belt guards, sheaves and drives and all other system components provided under this Contract requiring periodic replacement or maintenance. All piping shall be arranged in a manner to clear the openings of swinging overhead access doors, ceiling tiles and cleaning access doors in ductwork.

1. Access to any and all components requiring servicing, adjustment, calibration, maintenance or periodic replacement shall be provided so that the Owner's operations personnel can freely gain access without removal of any materials other than the access panel or ceiling tile. Access shall be understood to mean free, clear and unobstructed from the floor up to the device and/or component being serviced.

2. Fire rated access doors with closers shall be provided for all rated assemblies.

F. The Contract Drawings are diagrammatic only intending to show general runs and locations of piping, ductwork, equipment, terminals and specialties and not necessarily showing all required offsets, details and accessories and equipment to be connected. All work shall be accurately laid out with other Trades to avoid

conflicts and to obtain a neat and workmanlike installation which will afford maximum accessibility for operation, maintenance and headroom.

G. Where discrepancies in scope of work as to what Trade provides items, such as starters, disconnects, flow switches, electric control components, etc., exist, such conflicts shall be reported to the Architect prior to signing of the Contract. If such action is not taken, each Contractor, as applicable, shall furnish such items as part of his work, for complete and operable systems and equipment, as determined by the Architect.

H. Where drawing details, plans and/or specification requirements are in conflict and where pipe or duct sizes of same pipe or duct run are shown to be different between plans and/or between plans and sections or details, the most stringent requirement will be included in the Contract. HVAC systems and equipment called for in the specification and/or shown on the drawings shall be provided under this Contract as if it were required by both the drawings and specifications. However, prior to ordering or installation of any portion of work which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.

I. Final location of all air distribution devices, thermostats, heaters, control devices, etc., shall be coordinated with the Architectural reflected ceiling plans and/or other Architectural details, as applicable

1.11 COORDINATION DRAWINGS

A. Before materials are purchased, fabricated or work is begun, each Contractor shall prepare coordination drawings for all floors/areas, including buried systems/services (all-Trade-composite at ¼" scale), showing the size and location of his equipment and lines, in the manner described herein under General Requirements.

B. Coordination drawings are for the GC and Architect's use during construction and shall not be construed as shop drawings or as replacing any shop drawings. The coordination drawings, when corrected for actual "as-built" conditions, will be reviewed by the Architect, corrected and be used to prepare the Record Drawings to be submitted to the Owner for his use.

C. The cost of producing and reproducing the drawings will be included under the Contract of each Trade, including the cost or preparation of the Architectural building outlines. This process may include multiple revisions to these drawings which will be included in the cost. The intent is to provide a fully coordinated set of documents between trades no matter how many times they may have to be redone. The HVAC Contractor shall take the lead to produce the Architectural backgrounds, show all ductwork, piping, etc., and circulate the drawings to any of

his Subcontractors and the other Trades (Plumbing, Electrical), so that they can indicate all their work as directed by the GC and Architect as required, to result in a fully coordinated installation.

D. In addition to the regular coordination drawing review, the mechanical work will also be reviewed by the Architect/Engineer to ensure that the system and equipment arrangements are suitable to provide maintenance access and service as follows:

1. Valves and instrumentation should be grouped where possible and positioned in the best accessible locations.

2. Valves on pipes of 6" and larger, positioned above 7'-0" in height from the operating level, will be provided with chain operated valve wheels and be located where chains will not interfere with primary access through the mechanical room.

3. Location of control/diagnostic panels shall be shown and identified on the mechanical room coordination drawings.

E. Prepare a complete set of computer based MicroStation (Latest Version) drawings at scale not less than ¼" scale equals 1'-0", showing basic layout for the structure and other information as needed for preparation of Coordination Drawings. The drawings shall indicate the layout of all specialty tradework as indicated herein and shall be designated as Coordination Drawings. A signed liability release form will be required from the Contractor prior to the release of the disk from the Engineer.

F. Highlight all fire rated partitions on the Coordination Drawings for appropriate coordination.

G. The main paths for the installation or removal of equipment from mechanical and electrical rooms shall be clearly indicated on the Coordination Drawings.

H. Each of the specialty trades shall add its work to the base drawings with appropriate elevations and grid dimensions. Specialty trade information shall be required for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers and for spaces it the above ceilings where congestion of work may occur such as corridors and, where required, entire floors. Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions and other services. Indicate elevations relative to finish floor for bottom of ductwork and piping and conduit 6" greater in diameter.

1. Specialty Trade shall include:

a. Plumbing system.

b. HVAC piping and associated control systems.

c. Electrical.

d. Sheet Metal Work.

e. Automatic Temperature Control

f. Fire Alarm

g. Security

h. Telecommunications

i. Commissioning

I. Upon completing their portion of the Coordination Drawings, each specialty trade shall sign, date and return Coordination Drawings to the Contractor.

J. Where conflicts occur with placement of materials of various trades, the General Contractor shall be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by the affected specialty trade Subcontractor. The General Contractor shall then final date and sign each drawing.

K. Fabrication shall not start until Coordinate Drawings have been distributed to all parties as indicated herein.

L. Format: Coordination Drawings (plans only) shall be done using Micro Station (Latest Version), in either IBM or Mac Format. Disks shall be given to the Architect for future transfer to Owner. Coordination Drawings will be used as base for as-built drawings.

M. Distribution of Coordination Drawings:

1. The General Contractor shall provide one print of each Coordination Drawing to:

a. Each specialty trade Subcontractor.

b. Owner.

c. General Contractor.

d. Architect (for record purposes).

N. After distribution:

1. Resolve all interference's not previously identified.

O. Coordination Drawings include but are not necessarily limited to:

1. Structure.

2. Partition/room layout, including indication of smoke and fire resistance rated partitions.

3. Ceiling layout and heights.

4. Light fixtures.

5. Access panels.

6. Sheet metal, grilles, etc.

7. All heating piping and valves.

8. Major water and gases.

9. Major electrical conduit runs, panelboards, feeder conduit and racks of branch conduit. Motor control centers, starters and disconnects.

10. All equipment, including items in the Contract as well as O.F.C.I. and O.F.I. items.

11. Equipment located above finished ceiling requiring access for maintenance and service. In locations where acoustical lay-in ceilings occur indicate areas in which the required access area may be greater than the suspected grid systems.

12. Rainwater Piping.

13. Existing conditions, including, but not limited to, Mechanical, Plumbing and Electrical items.

14. ATC panels.

P. The Architect’s response to all requests for information (RFI’s) generated by the trade contractors shall be distributed to all other affected trades as if this information was contained in the original contract documents. In other words, the

party that issues an RFI is responsible for distributing the information to all affected parties.

1.12 RECORD DRAWINGS

A. Each Contractor shall maintain, current at the site, a set of Contract Drawings for his portion of the work on which he shall accurately show the actual installation of all work provided under his Contract indicating any variation from the Contract Drawings, in accordance with the General Conditions and Supplementary General Conditions. Changes whether resulting from formal change orders, requests for information, or other instructions issued by the Architect shall be recorded. Include changes in sizes, location and dimensions of piping, ducts, equipment, etc.

B. Each Contractor shall indicate progress by coloring-in various pipes, ducts and associated appurtenances exactly as they are erected. This process shall incorporate both the changes noted above and all other deviations from the original drawings whether resulting from job conditions encountered or from any other causes.

C. The marked-up and colored-up prints will be used as a guide for determining the progress of the work installed. They shall be inspected periodically by the Architect and Owner's representatives and they shall be corrected if found either inaccurate or incomplete. This procedure is mandatory. Marked up drawings shall include all flow diagrams, schedules, details and control diagrams.

D. Each Contractor shall meet at a minimum on a monthly basis, with the Owner's representative to transfer the information from his HVAC, Plumbing, etc., marked-up and colored-up prints to a set which will become the basis for preparation of as-built drawings.

E. Upon completion of the project, each Contractor shall submit his marked-up drawings to the Architect for review and comment. After the Architect reviews and comments on this set of documents, each Contractor shall prepare as-built drawings using MicroStation (Latest Version). When the work is completed, each Contractor shall provide 2 hard copies to the Architect for submittal to the Owner and disks with all documentation and a set of reproducible drawing plots marked "As-Built" drawings. The Contractor shall bear all costs of producing the CAD "As-Built" drawings, providing all necessary drawing changes and printing the reproducible drawings for the work under his charge.

1.13 GIVING INFORMATION

A. Each Contractor shall keep himself fully informed as to the shape, size and position of all openings required for his apparatus and shall give information to

the Architect and other Contractors [or Subcontractors] sufficiently in advance of the work so that all openings may be built in advance.

B. The manufacturers listed within this specification have been preselected for use on this project. No submittal will be accepted from a manufacturer other than those specified. Should any Contractor wish to propose a substitution during the bid period, such request shall be made in writing to the Architect, at least (15) working days, prior to bid date. If substitutions are deemed acceptable, such items shall be issued as an Addendum, prior to bid due date. The above requirement is mandatory.

1.14 EQUIPMENT AND MATERIALS

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information

B. Equipment and materials shall be delivered to the site and stored in original sealed containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect until installed. All items subject to moisture damage such as controls, filters, etc., shall be stored in dry, heated spaces.

C. Each Contractor shall have his equipment tightly covered and protected against dirt, water and chemical or mechanical injury and theft. At the completion of the work, equipment and materials shall be cleaned, polished thoroughly and turned over the Owner in a condition satisfactory to the Architect. Damage or defects developing before acceptance of the work shall be made good at each Contractor's [or Subcontractor's] expense as applicable.

D. Each Contractor shall make necessary field measurements to ascertain space requirements, for equipment and connections to be provided under his Trade and shall furnish and install such sizes and shapes of equipment to allow for the final installation to conform to the drawings and specifications.

E. Manufacturers' directions shall be followed completely in the delivery, storage, protection and installation of any equipment. Promptly notify the Architect in writing of any conflict between any requirements of the Contract Documents and the manufacturer's directions and obtain the Architect's written instructions before proceeding with the work. Should any Contractor perform any work that does not comply with the manufacturer's directions or written instructions from the Architect, he shall bear all costs arising in correcting any deficiencies that should arise.

F. Each Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to fully complete the work under his Contract for use, occupancy and operation by the Owner.

G. Where equipment of the acceptable manufacturers requires different arrangement or connections from those shown, it shall be the responsibility of each Contractor to install the equipment to operate properly and in harmony with the original intent of the drawings and specifications. When directed by the Architect, each Contractor shall submit drawings showing the proposed installation. If the proposed installation is approved, each Contractor shall make all necessary changes in all effected related work provided under other Sections including location of roughing-in connections by other Trades, electrical requirements, piping, supports, insulation, etc. All changes shall be made at no increase in the Contract amount or additional cost to the other Trades and/or Owner.

H. Testing Agency Labeling Requirements

1. All equipment and materials required for installation under these specifications shall be new and without blemish or defect.

2. Equipment and materials shall be products which will meet with the acceptance of the Authorities Having Jurisdiction over the work and as specified hereinbefore.

3. Where such acceptance is contingent upon having the FM Global, it shall be provided with FM Global label. Factory manufactured and assembled packaged equipment, such as the examples of equipment listed below, shall have the entire assembled package inspected and Labeled by Factory Mutual.

4. All equipment shall meet OSHA standards.

5. All products shall be listed and labeled by UL or other national testing laboratories such as ETL and the products shall be so labeled.

   a. Label of Underwriter's Laboratories, ETL or other nationally recognized testing agency acceptable to the Authorities Having Jurisdiction.

   b. This Labeling shall include not just the control panel and/or motor but all wiring and devices included in the package as a complete package. Note: Providing a series of individually labeled electrical devices that are then assembled into a package does not meet this requirement, the whole assembly must be labeled as an assembly. The manufacturers have the option of having the equipment inspected and Labeled at the factory or at the site after installation. This requirement shall supersede any other specification language hereinbefore or hereinafter that requires only portions of the equipment to be labeled.

c. Some examples of packaged equipment requiring Labeling:
   1) Boilers
   2) Feed water equipment
   3) Water pressure booster systems

I. All equipment of one type (such as valves, fans, plumbing fixtures, etc.), shall be the product of one manufacturer.

J. Equipment pre-purchased on behalf of the Owner or by the Owner himself, if assigned to any of the Contractors, shall be received, inspected, installed, etc., as if it was purchased by the Contractors as applicable. All guarantees, service contracts, etc., shall be the same as for all other equipment provided under this Contract.

1.15 CUTTING AND PATCHING

A. Each Contractor shall be responsible for all core drilling, as required for work under his Contract, but in no case shall he cut into any structural elements without the written approval of the Architect.

B. All cutting, rough patching and finish patching, shall be provided under this Contract.

C. All concrete and masonry equipment bases shall be provided under this Contract.

1.16 USE OF PREMISES

A. Each Contractor shall confine all of his apparatus, storage of materials and construction to the limits indicated on the drawings and directed by the Architect and he shall not encumber the premises with his materials.

B. In storing materials within areas (structure or ground), or when used as a shop, each Contractor shall consult with the General Contractor and shall restrict his storage to space designated for such purposes. Each Contractor will be held responsible for repairs, patching or cleaning arising from any unauthorized use of premises.

C. Notwithstanding any approvals or instructions which must be obtained by each Contractor from the Architect in connection with use of premises, the responsibility for the safe working conditions at the site shall remain each Contractor's. The Architect or Owner shall not be deemed to have any responsibility or liability in connection therewith.

1.17 PROTECTION/CLEANLINESS

A. All materials such as valves, fittings, piping, ductwork, plenums, grilles, registers, diffusers, etc., shall be properly protected from the accumulation of dirt, dust, debris or any other contaminants. All ductwork and piping openings shall be temporarily closed by each Contractor [or Subcontractor] installing same, so to prevent obstruction and damage, as a minimum at the end of each working day or more often if required by job conditions. Each Contractor shall take precautions to protect his materials from damage and theft.

B. Each Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or electrical systems provided under his Contract.

1.18 DAMAGE CORRECTION AND EXTRA WORK

A. Contractor shall be held responsible and shall pay for all damages caused by his work to the new and existing building structures and new and existing equipment, piping, duct systems, etc., and all work and finishes installed under this Contract in the new or in existing building. Repair of such damage shall be done as herein before specified, at the expense of each Contractor and to the Architect's satisfaction.

B. Each Contractor shall promptly correct all work provided under his Contract and rejected by the Architect as defective or as failing to conform to the Contract Documents whether observed before or after completion of work and whether or not fabricated, installed or completed. Each Contractor shall bear all costs of correcting such rejected work.

C. No claim for extra work will be allowed unless it is authorized by the Architect in writing before commencement of the extra said work.

1.19 TOUCH-UP PAINTING

A. Each Contractor shall thoroughly clean all equipment and systems provided under this Contract from rust, splatters and other foreign matter or discoloration, leaving every part of each system in an acceptable prime condition. Each Contractor, for the work under his Contract, shall refinish and restore to the original condition all equipment and piping which has sustained damage to the manufacturer's prime and finish coats of paint and/or enamel.

1.20 HOUSEKEEPING PADS

A. Coordinate housekeeping pads for:

1. All equipment indoors or outdoors

2. All floor supports or braces

B. Pads shall be 4" above the finished floor.

C. Each pad shall be a minimum of 6" larger then the equipment, support or isolation base in all directions.

D. Pads shall be formed, poured with concrete, and tooled by the General Contractor.

1.21 DUCT AND PIPE SLEEVES, PLATES AND ESCUTCHEONS, FIRESTOPPING AND SMOKEPROOFING

A. Where piping and/or ductwork pass through masonry or concrete walls or drywall partitions, each Contractor shall provide and set individual sleeves for each pipe or duct and all other work under his charge, as necessary for passage of all pipes and/or ducts. Sleeves shall be of sufficient size to provide 1/2" air space around the pipe or duct passing through (including insulation where pipes or ducts *are* internally/externally insulated). All openings shall be sealed, smokeproofed and made tight. Each Contractor shall be responsible for the exact location of sleeves provided under his Contract and shall coordinate all requirements for piping and ductwork sleeves.

B. Each Contractor, for work under his charge, shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation.

C. Sleeves and inserts shall not be used in any portions of the building, where their use would impair the strength or construction features of the building. Elimination of sleeves must be approved by the Architect.

D. Provide chrome plated brass escutcheons with set screw for exposed piping, in all areas except in mechanical rooms. In this area use plain brass or cast iron escutcheons suitable for painting. All escutcheons shall be sized to fit the bare pipe or insulation in a snug and neat manner. They shall be of sufficient size to cover sleeved openings for the pipes and of sufficient depth to cover sleeves projecting above floors. Escutcheons shall be as manufactured by Beaton & Caldwell, Dearborn Brass, or Grinnell.

E. Pipe or duct sleeves shall be made of Schedule 40 pipe, 20 gauge galvanized steel or 16 gauge steel as follows:

1. Sleeves on pipes passing through masonry or concrete construction shall be Schedule 40 pipe.

2. Sleeves on ducts passing through concrete construction shall be 20 gauge steel unless required otherwise by item 4. below.

3. Sleeves on pipes or ducts passing through fire rated partitions shall be 16 gauge steel.

4. Sleeves on pipes or ducts passing through non-rated drywall construction shall be 20 gauge galvanized steel.

F. Pipe or duct sleeves shall be set as follows:

1. Set sleeves 1" above finish floor, (except set sleeves, 6" above finish floor at penthouses or mechanical rooms and 6” above finished roof) and flush on each side of walls. Coordinate roof penetrations with roof Subcontractor.

2. Sleeves shall be set securely in place before concrete is poured when placed in concrete construction.

3. Provide sheet metal sleeves for all duct penetrations and cover with sheet metal plates all penetrations after ductwork has been installed through walls/floors.

G. Each Contractor shall fire stop, smoke stop, and/or acoustically seal the space between the sleeves provided under his Contract and piping or ductwork as applicable, as follows:

1. See Specification Section 230584 Through Penetration Firestopping System

H. Except as otherwise specified, underground piping passing through exterior walls or foundation slabs on grade, shall have penetration closures of the modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous belt around the pipe and with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and wall, reducing chances of cathodic reaction between these members. Each Contractor for work under his charge shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabrication or installation. The inside diameter of the wall opening shall be sized to fit the pipe and ensure a watertight joint. Where applicable, when installing seals, take into account the pipe O.D. if non-standard due to coating or jacketing.

1.22 MISCELLANEOUS IRON AND STEEL

A. Each trade shall provide all primary and secondary steel supports and hangers as shown on the drawings and/or as required to support equipment, ductwork, piping, exhaust fans, or any other materials provided under the work of this Section.

B. The work of this Section of designing, furnishing and installing all miscellaneous metal work associated with the system, and related items as indicated on the drawings and/or as specified herein, and includes, but is not limited to the items listed herein below.

C. The scope of work shall include:

1. Exhaust fan support platforms including ship ladders, steel grating for decking, cross-bracing and floor stands.

2. Intermediate beams to hang ductwork and piping from the roof. All piping and ductwork must be hung from beam or supported from the floor. Provide supplemental steel for support of equipment.

3. Support of ductwork and piping in shafts in addition to support provided by structure.

4. Support of ductwork via floor stands as required.

5. Piping support in underground concrete trench and manholes.

6. Pipe anchors in the building.

7. Hangers, brackets, angel irons or rods required for the support and protection of HVAC, plumbing and equipment.

8. Field prime painting of galvanized steel and field finish painting.

D. Shop Drawings for General Miscellaneous Items

1. Submit Shop Drawings of all miscellaneous metal items to Architect for approval, showing sizes and thickness of all members, types of materials, methods of connection and assembly, complete dimensions, clearances, anchorage, relationship to surrounding work by other Trades, shop paint, and other pertinent details of fabrication and installation.

E. The Subcontractor shall engage the services of a Professional Engineer registered within the state wherein the project is located to prepare complete Design Drawings and structural design computations based on, and closely following, the

design and details on the Drawings. The Design Drawings and structural design computations, with the Engineer's seal affixed thereto, shall be submitted to the Architect for review. The structural design computations shall provide a complete structural analysis, including anchors and fastening devices, and shall certify as to conformation to governing laws and codes. These submittals, upon review, must be sufficient, when taken in conjunction with this Specification to provide the complete basis of the fabrication and erection.

F. Samples

1. Submit duplicate samples of all materials to be furnished under this Section if, and in size and form, requested by Architect.

G. Do not order materials or begin fabrication until Architect's approval of submittals has been obtained.

H. In addition to the governing laws and codes, the following Specifications and Codes form a part of this Specification:

1. American Iron and Steel Institute applicable standards.

2. American Institute of Steel Construction "Code of Standard Practice for Steel Buildings and Bridges" and "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings".

3. American Welding Society Code: Standard Code for Arc and Gas Welding in Building Construction.

I. All materials shall be new stock, free from defects impairing strength, durability or appearance and of best commercial quality for each intended purpose.

1. Unless other wise specifically called for, work of this Section shall be fabricated of structural steel conforming to ASTM Specification A36.

2. Steel pipe shall be seamless steel pipe conforming to ASTM Specification A53, Schedule 40.

3. Steel tubing shall be seamless steel tubing conforming to ASTM Specifications A500 to A501.

4. Construction specialties such as slotted inserts, wedge inserts, etc., shall be as manufactured by Hohmann and Barnard, Gateway Erectors, Inc., Richmond Screw Anchor Co. or equal approved by Architect.

5. Non-ferrous metals shall be as specified under descriptions of specific items, herein below.

J. Provide all anchors, bolts, sockets, sleeves, and other parts required for securing each item of work of this Section to the construction, including furnishing to concrete workers all required insets and sleeves for use at concrete.

1. All exposed fastenings shall be of the same material and finish as the metal to which applied, unless otherwise noted.

2. Welding rods shall conform to AWS Standards and the recommendation of the welding rod manufacturer.

3. Shop primer for other ferrous surfaces shall be a high-quality, lead-free, rust-inhibitive primer, Tnemec No. 10-99 Metal Primer or equivalent by Devoe and Raynolds Co., Carboline or equal.

K. Metal surfaces shall be clean and free from mill scale, flake, rust and rust pitting. Metal work shall be well formed and finished to required shape and size, true to details, with straight, sharp lines and angles and smooth surfaces. Curved work shall be true radii. Exposed sheared edges shall be eased.

L. Weld all permanent connections. Welds shall be continuous on all exposed surfaces and where required for strength on concealed surfaces. Exposed welds shall be ground flush and smooth, with voids filled with metallic filling compound (metallic filling compound not permitted on surfaces to receive hot-dip galvanizing). Tack-welding will not be permitted unless specifically called for. Do not use screws or bolts where they can be avoided. Where used, heads shall be countersunk, screwed up tight, and threads nicked to prevent loosening.

M. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall give ample strength and stiffness. Joints exposed to weather shall be formed to exclude water.

N. Do all cutting, punching, drilling and tapping required for attachment of anchor bolts and other hardware and for attachment of work by other Trades. All such cutting, punching, drilling, etc., shall be done prior to hot-dip galvanizing of the various components.

O. Live loads shall be not less than the minimum required by law. Where specific live load are not set forth in the laws and codes applicable to this work, and are not given on the Drawings or in this Specification, designs shall be such as to support the live loads which may normally be imposed without failure, without deflection of more than 1/360 of length of any member, and without permanent deformation, all with a factor of safety of not less than 2 1/2 to 1.

P. Shop Painting

1. All ungalvanized ferrous metals under this Section shall be given a shop coat of rust inhibitive primer of type specified above.

    a. Immediately before shop painting, remove all rust, loose mill scale, dirt, weld flux, weld spatter, and other foreign material with wire brushes and/or steel scrapers. Power tool clean in accordance with SSPC SP-3 (Power Tool Cleaning). Remove all grease with oil by use of solvent recommended by paint manufacturer. Sandpaper exposed surfaces as required to produce smooth, even finishes.

    b. Apply paint by spray process in strict accordance with manufacturer's printed instructions to uniform thickness(es) recommended by manufacturer. Apply thoroughly and evenly and work well into corners and joints taking care to avoid sags and runs.

    c. Do not paint surfaces to be embedded in concrete, or to be welded in the field. After field welds are complete, grind smooth and flush, thoroughly clean and then apply specified primer over all unprimed in the field by brush roller.

    d. After erection, sand smooth and retouch all portions of the shop coats chipped or damaged during erection, and coat all field welds and connections with primer equivalent to that used for the shop coat.

Q. Installation

1. All materials shall be carefully handled and stored under cover in manner to prevent deformation and damage to the materials and to shop finishes, and to prevent rusting and the accumulation of foreign matter on the metal work. All such work shall be repaired and cleaned prior to erection.

2. Work shall be erected square, plumb and true, accurately fitted, and with the tight joints and intersections. All anchors, inserts and other members to be set in concrete or masonry shall be furnished loose by this Trade to be built-into concrete and masonry and by those Trades as the work progresses. Later cutting or drilling shall be avoided wherever possible.

3. All metal work shall be rigidly braced and secured to surrounding construction, and shall be tight and free of rattle, vibration, or noticeable deflection after installed.

4. Where members, other than expansion bolts or inserts, are fastened into concrete, set such members in holes formed as specified below, and secure permanently in place by installation of proprietary-type expanding grout manufactured specifically for such purpose, used strictly in accordance with manufacturer's directions. Holes to receive members shall be formed with galvanized sheetmetal sleeves, expanded polystyrene foam, or other approved method to provide at least 1/2 inch clearance around entire perimeter. At exposed applications, hold expanding grout back 1/2 inch from finish surface and fill voids with Portland cement grout to match color and texture of surrounding concrete surface.

5. Electrolytic Isolation

   a. Where dissimilar metals are to come into contact with one another, isolate by application of a heavy coating of bituminous paint on contact surfaces in addition to shop coat specified above. Do not permit the bituminous paint in any way to remain on surfaces to be exposed or to receive sealant.

R. Description of Major Items

1. The items described below constitute the major part of the work of this Section, but are not intended or implied to cover each and every item that may be required to properly complete the work. Carefully review the Drawings to determine the full extent of the miscellaneous metal work required.

S. Steel Ladders/Platforms

1. Fabricate and install interior steel ladder at fans, air handling units, filter racks and all equipment requiring service. Ladders shall have a safety cage as required by OSHA regulations.

2. Except as may be otherwise indicated on the Drawings, ladder shall be minimum 16 inches wide, fabricated of minimum 3/8 inch by 2 1/2 inches hot rolled steel rails and minimum 3/4 inches outside diameter steel pipe rungs. Rungs shall be spaced 12 inches on center and shall be continuously welded to the rails. Provide a pair of steel clip angles or wall brackets at bottom and steel anchor plates or wall brackets at top, welded to the rails, as indicated.

3. Exterior steel ladders shall be hot dip galvanized after fabrication as specified hereinbefore. Rungs are to have non-slip surfaces.

4. All shall be OSHA and ANSI compliant.

T. Gratings and Frames

1. Fabricated and install steel gratings and frames at fan platforms.

2. Steel grating frames shall consist of a steel angle perimeter frame constructed of steel angles, at least 4 inches by 4 inches by 3/8 inches carried around perimeter with coped or mitered, full-welded corners. Perimeter frames shall be anchored with 7/16 inch minimum diameter expansion bolts or other suitable devices of adequate capacity, at corners, two (2) per beam end, and spaced not more than 2 feet on center around full perimeter.

3. Steel Gratings shall be pressure-locked type, with bearing bars spaced 1 3/16 inch on center and cross-bars spaced 4 inches on center. Sizes of bars shall be as required by manufacturer's loading tables to limit deflection of any member across any span to 1/240th of the span at live load of 100 pounds per square foot. Gratings shall be as manufactured by Borden Metal Products, Co., Irving Subway Grating Co., Reliance Steel Products Co., approved by Architect.

4. All (gratings and) frames shall be hot-dip galvanized after fabrication as specified hereinbefore (aluminum, FRP).

U. Miscellaneous Items

1. Carefully review all Drawings for miscellaneous metal items required but not specifically listed above, such as miscellaneous steel clip angles, miscellaneous steel bracketing, and other miscellaneous metal items as indicated on the Drawings, reasonably implied therefrom, or reasonably necessary for the thorough completion of the work.

2. Provide rigid and secure anchorage of all components whether or not specifically described in complete detail on the Drawings.

V. Piping supports shall be coordinated with the building structure and shall span between roof beams as required.

1.23 WATERPROOFING, FLASHING AND COUNTERFLASHING

A. (Edit as applicable) Unless specifically indicated otherwise on the drawings, each Contractor shall provide all counterflashing and waterproofing of all piping, ductwork and equipment provided by him, which pierce roofs, walls and other weatherbarrier surfaces. All work under this paragraph shall be coordinated with the GC.

B. All work shall be performed in a workmanlike manner to ensure weatherproof installation. Any leaks developed due to each Contractor's work shall be repaired at his expense, to the Architect's satisfaction.

C. Pipes passing through slabs shall have the sleeve extended above floors as hereinbefore specified to retain any water and the space between the pipe and sleeve caulked waterproof fire stopping. The top and the bottom shall be sealed with monolastic caulking compound.

D. All flashing required for ductwork and piping penetrations shall be provided by the GC .

1.24 ELECTRICAL WORK, MOTORS, MOTOR CONTROLLERS

A. See Section 230513.

B. See Division 22 for Plumbing.

C. See Divisions 26, 27 and 28 for Electrical.

1.25 IDENTIFICATION OF MATERIALS

A. See Section 230553.

1.26 VALVE TAGS, NAMEPLATES AND CHARTS

A. See Section 230553.

1.27 PARTS LIST AND INSTRUCTIONS FOR OPERATION AND MAINTENANCE

A. Each Contractor shall thoroughly instruct the representative(s) of the Owner, to the complete satisfaction of the Architect, in the proper operation of all systems and equipment provided by him. Each Contractor shall make arrangements, via the GC as to whom the instructions are to be given in the operation of the basic and auxiliary systems and the periods of time in which they are to be given. The Architect shall be completely satisfied that the representative of the Owner has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by each Contractor to the Owner's representative, then each Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the specification has been complied with. All time required for Owner's instruction to satisfy the above requirements shall be included in this Contract. No extra compensation for such instructions will be allowed.

B. Each Contractor, including but not limited to, the HVAC Contractor, shall submit to the Architect for approval, a total of (6) typed sets, bound neatly in loose-leaf binders, of all maintenance and operating instructions for the installation, operation, care and maintenance of all equipment and systems. All data and literature furnished shall be specific for the make and model of the equipment furnished. General non-specific catalog data will not be acceptable. Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section such as fans, valves, plumbing fixtures, hot water heaters, boilers, air handling units, etc., shall be clearly divided from the other sections. A sub-index for each section shall also be provided. The methodology of setting-up the manuals shall be submitted to the Architect and Owner through the General Contractor for approval prior to final submission of manuals.

C. The instructions shall contain information deemed necessary by the Architect and shall include, but not be limited to, the following:

1. Instructional classes on equipment and systems operation for Owner's representative and maintenance personnel, by engineering staff of each Contractor. Minimum of 48 hours of instruction for minimum of (6) people. Instruction shall include:

    a. Explanation of manual and its use.

    b. Summary description of the HVAC systems.

    c. Purpose of systems.

2. System

    a. Detailed description of all systems.

    b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.

3. Operations

    a. Complete detailed, step-by-step, sequential description of all phases of operation for all portions of the systems, including start-up, shutdown, adjusting and balancing. Include all posted instruction charts.

4. Maintenance

    a. Parts list and part numbers.

b. Maintenance, lubrication and replacement charts and manufacturer's recommendations for preventive maintenance, as applicable to his work.

c. Troubleshooting charts for systems and components.

d. Instructions for testing each type of part.

e. Recommended list of on-hand spare parts.

f. Complete calibration instructions for all parts and entire systems.

g. Instruction for charging, filling, draining and purging, as applicable.

h. General or miscellaneous maintenance notes.

5. Manufacturer's Literature

a. Furnish complete listing for all parts required for models actually furnished.

b. Names, addresses and telephone numbers of manufacturers and suppliers.

c. Describe and operation of all models actually furnished.

d. Furnish all and only pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.

e. Internal wiring diagrams and engineering data sheets for all items and/or equipment furnished under each Contract.

f. Guarantee and warranty data.

6. Each Contractor shall furnish instructions for lubricating each piece of equipment installed by him. Instructions shall state type of lubricant, where and how frequently lubrication is required. Frame instructions under glass and hang in a location as directed by Architect.

1.28 MANUFACTURER'S REPRESENTATIVE AND COMMISSIONING OF SYSTEMS

A. Each Contractor shall provide, at appropriate time or as directed by the Architect, the on-site services of a competent factory trained Engineer or authorized

representative of particular manufacturer of equipment provided under his Contract, such as for the automatic temperature controls, building automation system (BAS), Snow Melt System, boilers, etc., provided under this Contract, to instruct the Owner, inspect, adjust and place in proper operating condition any item provided by him, as applicable.

B. The HVAC Contractor, as applicable, shall commission and set in operating condition all major equipment and systems, such as the condenser water, hot water and all air handling systems, etc., in the presence of the applicable equipment manufacturer's representatives, and the Owner and Architect's representatives. In no case will major systems and equipment be commissioned by any of the Contractor's forces alone, without the assistance or presence of the equipment manufacturers.

C. A written report shall be issued by the particular equipment manufacturer and the Mechanical Contractor summarizing the results of the commissioning and performance of each system for the Architect's record. No additional compensation will be allowed for any Contractor for such services.

D. The Contractor shall prepare and submit to the Architect for acceptance, a schedule of anticipated system commissioning. No system shall be commissioned without prior acceptance of the schedule by the Architect and Owner. No systems shall be commissioned prior to submittal and acceptance of Operation and Maintenance Manuals.

1.29 CONNECTIONS TO EQUIPMENT

A. Each Contractor shall provide all duct and/or pipe connections, condensate traps, drains, overflows, relief valves and vents, power connections, etc., to make equipment operable, as provided under other Sections of the specifications, as shown on the Architectural and/or each Trade's drawings and herein specified, including final connections to equipment to result in a complete system, fully operational. Coordinate location of all equipment with Architect. Obtain installation diagrams and methods of installation of all equipment from manufacturers. Follow instructions strictly. If additional information is required, obtain same from Architect. If equipment is indicated on the Architectural drawings, it shall also be construed and understood by the Mechanical Contractor to be constructed as shown on the HVAC drawings and shall be fully serviced and connected at no extra cost to the Owner.

1.30 ELECTRICAL ROOM REQUIREMENTS

A. The HVAC Contractor [or Subcontractors] shall not install any piping, ductwork or equipment in or through electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms, unless piping, ductwork or

equipment is intended to serve these rooms. If any Contractor violates this requirement, he shall remove and/or relocate all items as required at his expense and to the satisfaction of the Architect.

1.31 HOISTING EQUIPMENT AND MACHINERY

A. All hoisting equipment and machinery required for the proper and expeditious prosecution and progress of the work under this Contract shall be furnished, installed, operated and maintained in safe condition by each Contractor for his material and/or equipment delivered to the designated hoisting area. All costs for hoisting operating services shall be borne by the Mechanical Contractor for all equipment and work under his charge.

1.32 STAGING

A. All staging, exterior and interior, required to be over 8'-0" in height, shall be furnished and erected by each Contractor for work under his charge and maintained in safe condition by him for proper execution of his work.

1.33 CONTROL WIRING

A. The ATC Contractor shall provide all control and interlock wiring for all systems provided under the HVAC, plumbing and ATC Contracts.

B. All control wiring shall be installed in conduit and in accordance with the respective equipment manufacturer's requirements, and all connections shall be provided by the Mechanical and/or the ATC Contractor. All conduit and wiring provided by these Contractors shall be installed in accordance with the requirements of Section 26 of the specifications.

1.34 COMPONENT COORDINATION

A. The HVAC, ATC and Electrical Contractors Scope of Work shall be implements in accordance with the following matrix:

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring
Supply and Exhaust Boxes	23	23	N/A	25	N/A
Sheet Metal Damper	23	23	N/A	N/A	N/A
Sheet Metal Damper Actuators	25	25	N/A	25	N/A
DDC Panels	25	25	26	25	N/A
Control Valves	25	23	25	25	N/A

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring
VFDs (VSDs)	23	26	26	25	N/A

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

PART 3 – EXECUTION

3.01 NOT USED

END OF SECTION 230500

SECTION 230513 – MOTORS AND CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all motors required for all mechanical equipment specified under this Division.

B. Furnish and install all individual motor controllers, starters and disconnect switches not provided under Divisions 26, 27 and 28 – Electrical Work.

C. All motors shall be premium efficiency suitable for the duty and voltage service available and as indicated on the contract drawings.

D. Provide all necessary control transformers so all motors, starters, disconnect switches, etc. are compatible with the control and operating sequences specified.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. AFBMA: Anti-Friction Bearing Manufacturers Association.

    a. 1-84 – Terminology for Anti Friction Ball and Roller Bearings and Parts.

    b. 9-84 – Load Ratings and Fatigue Life for Ball Bearings.

    c. 11-78 – Load Ratings and Fatigue Life for Roller Bearings.

2. 20-77 – Metric Ball and Roller Bearings Conforming to Basic Boundary Plans.

3. ANSI: American National Standards Institute.

    a. 50-84 – Mechanical Vibration of Rotating and Reciprocating Machinery.

4. ASTM: American Society for Testing and Materials.

    a. A48-83 – Gray Iron Castings.

    b. B117-85 – Method of Salt Spray (Fog) Testing.

5. IEEE: Institute of Electrical and Electronic Engineers.

    a. 1-86 – General Principals for Temperature Limits in the Rating of Electrical Equipment.

    b. 85-73 – Test Procedures for Airborne Sound Measurements on Rotating Electric Machinery.

    c. 112-84 – Standard Test Procedures for Polyphase Induction Motors and Generators.

    d. 114-82 – Test Procedures for Single-Phase Induction Motors.

    e. 117-74 – Test Procedures for Evaluation of Systems of Insulating Materials for Random-Wound AC Electric Machinery. Single-Phase Induction Motors.

6. NEMA: National Electrical Manufacturer’s Association.

    a. MG 1-78 – Motors and Generators.

7. NFPA: National Fire Protection Association.

8. National Electrical Code.

9. SAE: Society of Automotive Engineers.

10. SAE Grade 5.

1.05 SYSTEM DESCRIPTION

A. Furnish an install all premium efficiency motors for all systems and equipment.

B. Motor Controllers: Provide individual motor controllers not provided under Division 26. Coordinate with the Division 26 Contractor to determine the location, size and number of individual motor controllers to be provided under this Division.

C. Mounting and installing of motors and drives.

D. Installation of motor controllers supplied under this Division.

E. Work shall be done in accordance with requirements of Division 26 “Electrical Work”. Wiring shall be done under Divisions 26, 27 and 28.

F. Disconnect switches; Provide combination motor controller and disconnect switch where required under Division 23 as specified in Division 26. If not specified under individual product sections, then disconnect switches shall be furnished and installed under Division 26.

1.06 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for Additional Requirements.

C. Product Data: Provide product description and list of materials including all motor efficiency ratings.

D. Manufacturer’s Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.07 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.08 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01

B. Manufacturer regularly engaged in the design, testing and manufacturing of specified products and issuing complete catalog data on such products.

C. Manufacturers must prove expertise in the design, testing and production of specified or similar to specified products for at least ten (10) years prior to date of bid.

D. Manufacturer must provide written certification that the products provided meet or exceed the specification requirements. An executive officer of the company must sign the written certification.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Delivery of materials shall be made to the project by the materials supplier in accordance with the instructions of the Contractor.

C. The Contractor shall provide adequate storage space for the materials, shall be responsible for all items of materials after receipt from the supplier, and shall replace all materials lost or damaged after delivery and receipt.

D. The Contractor shall furnish the materials supplier with receipts for all materials and accessory items received, and shall send copies of these receipts to the Architect.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 ACCEPTABLE MANUFACTURER CONTINGENT ON COMPLIANCE WITH SPECIFICATIONS

A. Motors:

1. Baldor or approved equal.

B. Motor controllers:

1. General Electric or approved equal

2.03 GENERAL

A. All control wiring shall be installed in conduits and in accordance with the respective equipment manufacturer requirements. All connections shall be provided by the HVAC Contractor. All conduit and wiring provided by the Mechanical Contractor shall be installed in accordance with the requirements of Division 26 of these Specifications.

B. Motors shall be built in accordance with latest Standards of NEMA and as specified. Motors shall be specifically and expressly wound for voltage required.

C. Motors shall be tested in accordance with ANSI 50 and conform thereto for insulation resistance and dielectric strength.

D. Motors shall be provided with adequate starting and protective equipment as specified or required and with conduit terminal box of size adequate to accommodate conduits and wires.

E. Capacity shall be sufficient to operate motors under job conditions of operation and load, without overload and shall be at least the horsepower size indicated or specified.

F. All motors shall be suitable for continuous duty at rated horsepower, with temperature not to exceed 40°C ambient (with a 1.15 SF). All motors shall be capable of 15% overload without overheating. All motors shall be rated and certified for use with VFD's per NEMA MG1 section 31.

G. All motors shall be rated for inverter duty, and stamped as such. All motors shall have Class F insulation or higher temperatures.

1. Manufactured to maximize Corona Inception Voltage (CIV) rating.

a. The minimum acceptable shall be 2500 Volts at 155°C.

2. Windings shall be in-slot wound type

H. Direct connected motors shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable sliding bases, except for fractional motors which shall be furnished with slotted mounting holes.

I. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, speed and current characteristics.

J. Motors smaller than 1/2 HP shall be capacitor, starter or split-phase type. Motors 1/2 HP and larger shall be squirrel cage, induction type. Motors 1 HP and larger shall have grease lubricated ball bearings and approved grease fittings. Motors provided shall have voltage, phase and hertz characteristics, as scheduled on the drawings.

K. Except for electrical apparatus specifically called for to be provided under this Contract, all motor starters, disconnect switches, controllers and other electrical appurtenances required under the HVAC, Plumbing, Fire Protection, etc. work, shall be provided under Division 26. Study the Electrical drawings and coordinate requirements and quantities with the Electrical Contractor.

L. All electrical apparatus and controls furnished as a part of the HVAC, Plumbing, Fire Protection, etc. work shall conform to applicable requirements under Electrical Section.

M. Each Contractor shall provide the Electrical Contractor with all motor size and wiring requirements within (30) days from date of Contract to allow proper coordination of Trades by the General Contractor.

N. Each Contractor shall verify with the Electrical Contractor available electrical characteristics before ordering any equipment or motors.

O. Equipment which includes a number of correlated electrical control devices mounted in a single enclosure or on a common base with equipment, shall be supplied for installation completely wired internally with terminal strip ready for external wiring. Unless specifically directed otherwise in the Contract Documents, if these control devices are separately mounted they shall be furnished by the HVAC Contractor and wired by ATC Contractor or Electrical Contractor in accordance with the manufacturer's wiring diagram, as shown on the drawings and as specified hereinafter.

P. All motors shall meet NEMA vibration requirements and shall be less than 0.15 in./sec.

2.04 MOTORS

A. In accordance with NEMA, IEEE and ANSI 50 Standards.

B. Capacity: Minimum of indicated horsepower and to operate driven devices under all conditions without overload.

C. Provide all of the same manufacturer, except those provided integrally with equipment.

D. Motor type and application (1/2 hp and above):

1. Conditioned areas and heated ventilated areas protected from weather:

    a. Squirrel-cage induction type, open drip-proof, NEMA B design, rated for 90 degree C rise over 40 degree C ambient, Class B insulation up to 1 hp and class f insulation above 1 hp, 1.15 service factor, continuous rating per NEMA MG1-1.40.

    b. Unless otherwise noted on the mechanical contract drawings or specified.

2. Motors installed outdoors, on roofs and out of building airstreams:

    a. Squirrel-cage induction type, totally enclosed fan cooled, NEMA B design, class B insulation, up to 1 hp and Class F insulation above 1 hp 1.15 service factor, continuous duty unless otherwise noted on the contract drawings or specified.

E. Motor shall be 1800 rpm single speed motors unless otherwise noted on the contract drawings.

F. Motor type and application (less than ½ hp).

1. Built in overload protection.

2. Rewinding tap, permanent split capacitor type, unless otherwise noted on the contract drawings or specified.

3. Suitable for service and location.

4. Motor shall be 1800 rpm single speed motors, unless otherwise noted on the contract drawings.

G. Motor voltages:

1. Motors less than ½ hp: Single phase, 60 hertz, 120 volt, AC, unless otherwise indicated on the contract drawings.

2. Motors ½ hp and up. Suitable for 3 phase, 60 hertz, 480 volt, AC power source, unless otherwise indicated on the contract drawings.

H. Motor Efficiency Ratings And Construction

1. Motors 1.0 hp up to 250 hp: Suitable for 3 phase, 60 hertz, 480 volt, AC power source, premium-efficient type, unless otherwise noted on the contract drawings as specified.

2. Guaranteed minimum power factor at full load and rated voltage and guaranteed minimum efficiency at full load and rated voltage when tested in accordance with IEEE Test Procedure 112A, Method B.

3. Premium-efficient type motors shall conform to the following efficiencies:

Nominal Efficiencies For NEMA Premium Efficiency
Motors Rated at 600 Volts or Less

	Open Drip Proof			Totally Enclosed Fan-cooled		
HP	6 pole	4 pole	2 pole	6 pole	4 pole	2 pole
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2

Nominal Efficiencies For NEMA Premium Efficiency Motors Rated at 5kV or Less

	Open Drip Proof			Totally Enclosed Fan cooled		
HP	6 pole	4 pole	2 pole	6 pole	4 pole	2 pole
250	95.0	95.0	94.5	95.0	95.0	95.0
300	95.0	95.0	94.5	95.0	95.0	95.0
350	95.0	95.0	94.5	95.0	95.0	95.0
400	95.0	95.0	94.5	95.0	95.0	95.0
450	95.0	95.0	94.5	95.0	95.0	95.0
500	95.0	95.0	94.5	95.0	95.0	95.0

4. Motors less than 1 hp shall be manufacturer's standard premium efficiency design.

5. Motor nameplate shall be specially marked "energy efficient motor" or similar nomenclature.

6. Motors built in accordance with current NEMA Standard MG-1 except as noted.

    a. Motors NEMA Design B, NEMA T-frame sizes.

    b. Insulation tested by manufacturer, Class F or better. Test per NEMA MG1-12.03.

    c. Temperature rise limits in accordance with NEMA limits for insulation class, service factor and enclosure specified.

I. Materials and Construction:

1. Motors up to 5 hp

    a. Steel motor frames, cast aluminum end brackets, steel terminal box, copper windings.

2. Motors 5 hp and larger:

    a. Cast iron motor frames, cast iron end brackets, cast iron terminal box, copper windings.

3. TEFC Motors

    a. Cast iron motor frames, cast iron end brackets, cast iron terminal box, copper windings, corrosion resistant fan internals, epoxy varnish coated for corrosion protection, cadmium plated hardware.

b. Severe duty motors:

1) Cast iron construction (frame, end brackets and terminal box). External hardware, fan and fan cover coated or plated to prevent corrosion or corrosion-resistant material. Air gap surfaces coated with epoxy or zinc chromate. Shafts with rotating shaft mounted slingers or seals to prevent entry of contaminants at each end. Epoxy insulation system where used in high-moisture and corrosive atmospheres.

4. Explosion proof motors:

a. UL listed for application or duty.

b. Motors shall conform to requirements defined in Article 500, 501, 502, 503 of the National Electric Code.

c. Motor nameplate shall be specifically marked “explosion proof” or similar such nomenclature.

5. Sound-power levels no greater than recommendations of NEMA (MG1-12-49).

J. Motors 1/2 hp and above, conform to following:

1. Bearings: Antifriction type with bearing housings equipped with easily accessible plugged provisions for relubrication. Minimum L-10 life of 100,000 hours based on direct drive equipment. Bearing housings shall be equipped with grease openings for simultaneously adding new grease and purging the old grease. Provide corrosion resistant plugs or caps on grease openings.

2. Belt-connected motors: NEMA foundation slide base and shaft as required for aligning pulleys. Minimum L-10 life based on belt drive shall be 40,000 hrs.

3. Motor enclosure: Suitable for service and location.

2.05 MOTOR DISCONNECT

A. Provide only devices of Specification Grade, UL listed and labeled, manufacturer’s certification to meet applicable Federal Specifications, and to meet NEMA performance standards.

B. Disconnects shall be “Heavy Duty Type”.

C. Single phase disconnect switches: Two pole toggle operated AC manual motor starting switch without overload protection for single phase motors.

D. Three phase disconnect switches: 3 pole fusible or unfusible as required; 250 or 600 volt as required in NEMA 4 enclosures.

E. The operating handle for three phase disconnect switches shall be of the box-mounted type that directly drives the switch mechanism.

F. Three phase disconnect switches shall have a defeatable, front accessible, interlock to prevent the opening of the cover when the switch is in the "ON" position and prevent turning the switch "ON" when the door is open.

G. Solid neutral: Provide as required.

H. Provide ground lug for ground wire termination.

I. All disconnects shall be lockable.

J. Operating handle: Lockable in either open or closed position.

K. All motor disconnects shall be horsepower rated.

L. Feed through or double lugged: UL approved for the purpose.

M. Installation:

1. All switches shall have a nameplate indicating the circuit number feeding the switch. Nameplate shall be laminated black with white letters engraved.

2. Install a motor disconnect switch with every motor unless noted otherwise on mechanical equipment schedules.

2.06 MOTOR CONTROLLERS

A. Manual motor controller:

1. For single phase motors, provide H-O-A switches with thermal overload.

2. 2-speed: Fast-slow-off selector switch with overload protection for each speed, with pilot lights for slow and fast speed.

B. Magnetic motor controller:

1. Provide magnetic contactors with three overload relays, for motor running overload protection, per NEC.

2. 120 Volt holding coil.

3. Provide status pilot light in cover, red for energized. Pilot light shall be operated by an extra interlock (not placed across holding coil). Pilot light shall be long life (130 volt) type 6S6 incandescent lamps.

4. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off-Auto or Start/Stop pushbutton.

5. Provide one set of convertible auxiliary contacts in addition to standard auxiliary holding contacts supplied with each contactor.

6. Provide control transformer 120 volt secondary of sufficient capacity to handle operating coil and associated controls plus 75 volt amps.

7. Provide surface mounted starters in NEMA Type 1 enclosure for indoor applications and NEMA Type 4 enclosure for outdoor applications.

8. Contacts shall be solid-silver cadmium oxide alloy which will not require any filing, dressing or cleaning throughout the life of the control equipment. Bare copper or silver flashed contacts shall not be permitted.

9. Operating coils shall be pressure molded. When a coil fails under over-voltage condition, the motor controller shall drop out.

10. Overload relays shall be of the hand-reset, trip-free variety so that blocking the reset mechanism in the reset position will not prevent the starter from dropping out if the motor is overloaded. This specifically excludes those overload relays which change to automatic reset from hand-reset when the reset mechanism is blocked unless the automatic reset feature can be removed or voided. Accidentally depressing the reset button or mechanism shall not shut off the motor. Overload relays shall not be field convertible from hand to automatic reset type.

11. Disconnect switch shall be provided under Division 26 unless otherwise noted.

12. Where specified, motor hp rated disconnect switches shall be provided in NEMA 1 enclosure for indoor applications and NEMA 4 enclosures for outdoor applications.

13. Provide full coordination between settings or ratings of protective devices in accordance with the NEC.

C. Combination motor controller (only where indicated on the contract drawings or specified).

1. Provide molded case circuit breakers with rotary operating handle and lock-off facility.

2. Restrict opening of switch enclosure by the use of a defeater screw unless switch is in the OFF position.

3. Provide contactors with three overlay relays.

   a. 120 Volt holding coil.

   b. Provide status pilot light in cover, red for energized. Pilot light shall be operated by an extra interlock (not placed across holding coil) Pilot lights shall be long life (130 volt) type 6S6 incandescent lamps.

4. Provide reset button, and Hand-Off-Automatic switch in cover, field convertible to Off/Auto or Start/Stop pushbutton.

5. Provide one set of auxiliary contacts in addition to standard auxiliary hold contacts supplied with each contactor.

6. Provide control transformer 120 volt secondary of sufficient capacity to handle operating coil and associated controls plus additional 75 volt amps.

7. Time-delay relays shall be adjustable, pneumatic type, 2 to 60 seconds and operate on 120 volts, 60 hertz. They shall have at least one normally open and one normally closed timed contact. The type of operation is as indicated or required.

PART 3 – INSTALLATION

3.01 MOTORS

A. Coordinate with appropriate trades.

   1. Motor and base mounting requirements.

   2. Motor electrical requirements.

B. Motors shall be installed in accordance with manufacturer’s installation instructions.

C. Motors shall be installed in accordance with all applicable codes.

3.02 CONTROLLER

A. Provide all controllers not indicated on Electrical drawings.

END OF SECTION 230513

SECTION 230514 – VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish variable frequency drives (VFDs) for mechanical equipment as scheduled on the drawings and specified herein. The term VFD shall refer to the entire assembly including but not limited to the by-pass.

B. The VFDs shall be installed and wired by the electrical contractor. Coordinate work with the electrical contractor.

C. The VFD's shall comply with the latest applicable standards of ANSI, IEEE, NEMA, NEC, UL and City Test Lab. The controllers shall be rated as indicated. As a minimum, the full load output current of the drive shall be equal to the equivalent motor horsepower as listed by NEC Table 430-150.

D. Drive horsepowers shall be minimum size as indicated. Coordinate size with driven equipment manufacturer.

E. Provide UL listed, accessory reactors to be UL listed. Bypass panels shall be constructed of UL recognized components assembled in a UL listed enclosure in strict accordance with the NEC for electrical safety. In addition the assembly shall be UL listed.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. IEEE: Institute of Electrical and Electronic Engineers

2. NEMA: National electrical Manufacture's Association

3. MG 1-78: Motors and Generators

4. NEC: National Electrical Code

5. ANSI: American National Standards Institute

6. UL: Underwriter's Laboratories

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. Product Data: Provide product description and list of materials, including the following:

1. Harmonic calculations

a. List of all drives.

b. Simplified one line diagram indicating linear as well as drives, transformers and PCC.

c. Technical description of the program used for the calculations.

d. Description of all inputs and outputs from the program.

2. Complete drawings furnished and approved before proceeding with manufacture. Drawings shall consist of a specific bill of materials, connection diagrams and suitable outline drawings showing details necessary to locate conduit stub-ups and field wiring.

   a. Details including all labeling.

   b. Assembled panel short circuit rating and how it will be labeled.

   c. Heat release of the drive.

3. Description of field testing.

   a. Proposed schedule of testing indications coordination with occupancy.

4. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturers must have more than ten (10) years of documents experience in the design, testing and manufacturing of specified or similar products.

C. Manufacturer must provide written certification that the products provided meet or exceed the specification requirements. An executive officer of the company must sign the written certification.

1.08 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.09 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Attention is directed to provisions of the General Conditions and Supplementary General Conditions regarding guarantees and warranties for work under this Contract.

C. Manufacturers shall provide guarantees for work under this Contract. However, such guarantees shall be in addition to and not in lieu of all other liabilities which the manufacturer and the Contractor may have by Law or by other provisions of the Contract Documents.

D. All materials, items of equipment and workmanship furnished under each Section shall carry the standard warranty against all defects in material and workmanship. Any fault due to defective or improper material, equipment, workmanship or design which may develop shall be made good, forthwith, by and at the expense of the Contractor including all other damage done to areas, materials and other systems resulting from this failure.

E. The Contractor shall guarantee that all elements of the systems provided under his Contract, are of sufficient capacity to meet the specified performance requirements as set forth herein or as indicated.

F. Upon receipt of notice from the Owner's representative of failure of any part of the systems or equipment during the warranty period, the affected part or parts shall be replaced by the Contractor, within three (3) working days, at no cost to the Owner.

G. The Contractor shall furnish a written guarantee covering the above requirements before the final payment is made.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 VARIABLE FREQUENCY DRIVES

A. General

1. Provide a complete variable frequency drive (VFD) (in a single enclosure) of capacity, quantity and characteristics as described in this specification and as shown and scheduled on the drawings. Acceptable manufacturers contingent on compliance with specifications are:

a. 25 HP and Less (6 Pulse or Greater)

1) General Electric or approved equal

2. All VFDs shall be of the same manufacturer.

3. Each drive and assembly shall be U.L. listed and labeled.

a. Label shall include the AIC rating for the assembly which shall not be less then 100,000 AIC. Any unit shipped without such label shall be removed from the job with NO EXCEPTIONS. This also includes six pulse drives with or without bypasses.

4. Each drive shall be mounted with it's accessories in a single cabinet.

5. Installation and start-up services for the equipment shall be covered by this specification.

6. Input control signal shall be compatible with automatic controls and/or building automation control system. Submit written, signed off coordination with submittal.

7. Complete drawings shall be furnished and approved before proceeding with manufacture. Drawings shall consist of a specific bill of materials, connection diagrams and suitable outline drawings showing details necessary to locate conduit stub-ups and field wiring.

8. The VFD shall comply with the latest applicable standards of ANSI, IEEE and NEMA. The controllers shall be rated as shown in the drawings. As a minimum, the full load output current of the drive shall be equal to the equivalent motor horsepower as listed by NEC Table 430-150.

9. Drive horsepowers shall be minimum size as indicated. Coordinate size with driven equipment manufacturer.

10. The VFD manufacturer shall supply with submittal information, harmonic calculations made in accordance with IEEE 519-1992 Standards showing the specified THVD, line notching and the specified THCD limits are met. Calculations shall assume worst case system conditions. System 1-line, 480V transformer data, standby generator data, and primary fault current data required to make these calculations are provided in the system short

circuit study and can be obtained from the Electrical Contractor. The submittal shall include, as a minimum, the following information:

a. All input data and assumptions.

b. Explanation of method used to perform the analysis.

c. All calculations and computer printouts used in the analysis, including input documentation.

   1) List all drives and accessories.

   2) Explanation of all inputs

   3) Explanation of all outputs.

d. A system impedance diagram based on the Electrical one-line diagrams. It shall be the drive manufactures responsibility to obtain all information required.

e. All calculations shall be in accordance with IEEE 519 with all drives at 100% speed. The point of common coupling shall be the secondary connection of the transformer supplying that group of devices. These calculations shall be done with the transformer loaded to no more than 70% of its nominal capacity (without fans). These calculations shall also be done with all 18-pulse or greater drives running as well as the smaller drives running.

f. Each point of common coupling shall be defined as the secondary side of the transformer that feeds that group of drives. At the point of common coupling, the following numbers shall meet with the maximum load on the transformer no greater than 70% of its nominal capacity.

   1) **Total harmonic voltage distortion is less than 3%**

   2) **Total harmonic current distortion is less than 5% and harmonic table requirements I_{SC} / I_L <20**

   3) **<u>Note</u>: 6-pulse drives will not be accepted on 30 HP drives or larger, even if this calculation is met.**

g. A detailed description of the tests, procedures and supporting calculations required to substantiate the installed systems compliance with the specified THD limits.

1) The description shall include information on the proposed test equipment and test conditions.

2) Include the name and qualifications of the firm which will conduct the field tests.

h. **Submittals without calculations will not be reviewed**.

11. Drives shall be capable of the full rated motor horsepower at all carrier frequencies of that drive.

B. Construction

1. VFDs 25 HP and Less

a. VFDs 25 HP and less shall be 6-pulse (or greater) input. Provide data and calculations showing the drive harmonics.

b. 5% line reactors shall be provided on each drive as a minimum.

c. The use of the following devices is <u>not permitted</u>:

1) Passive filters.

2) Broad band filters.

d. The use of the following devices is permitted:

1) Changing additional drives to 18 pulse or greater.

2. Harmonic Table

I_{SC} / I_L	**Harmonic Order (Odd Harmonics)**					**THD**
	H<11	**11<h17**	**17<h23**	**23<h35**	**35<h**	
<20	4.0	2.0	1.5	0.6	0.3	5.0
20-50	7.0	3.5	2.5	1.0	0.5	8.0
50-100	10.0	4.5	4.0	1.5	0.7	12.0
100-1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

3. 18 Pulse Transformer

a. Auto transformer

1) Voltage 480.
2) Input variation less than 3%.
3) Insulation Class 220°C
4) Temperature rise 150°C
5) With 7.5% AC input line reactors for proper current balance.
6) Output Voltage unbalance less than 2% for each bridge
7) Output current shall be 1/3 of rated input

b. Isolation Transformer.

1) Voltage 480.
2) Input variation less than 3%.
3) Output Voltage unbalance less than 2% for each bridge
4) Output current shall be 1/3 of rated input

4. All Drives

a. The VFD shall be of the pulse width modulated (PWM) design converting the fixed utility voltage and frequency to a variable voltage and frequency output via a 2-step operation. VFDs utilizing a 3rd power section are not acceptable. Efficiency shall exceed 96% at 100% speed and load. Line side displacement power factor shall exceed (0.95) regardless of speed and load. The VFD shall be rated for 110% current for (1) minute for variable torque loads and 150% current for (1) minute for constant torque loads.

b. VFDs located indoors shall be housed in a signal NEMA 1 metal enclosure (including 18-pulse transformer, filters, line reactor, and other required accessories.

c. Drives located outside shall be provided with a single NEMA 3R enclosure and an independent heating and cooling system to maintain manufacturer’s ambient operating conditions.

d. Drives located other than outside (submit list of all drives individually indicating):

1) Space drive is located.

2) Space ventilation is adequate, space air conditioning is adequate or the size of the cooling provided in the drive.

3) Space heating is adequate or the size of the heater provided in the drive.

e. Standard operating conditions shall be:

1) Incoming 3-phase 480 VAC power, +5% or -10%, 60 Hz.

2) Humidity 0 to 95% (non-condensing and non-corrosive).

3) Altitude 0'-0" to 3,300'-0" above sea level.

4) Ambient temperature 0° to 40°C.

f. VFDs shall include the following system interfaces:

1) Speed reference interface with a differential amplifier or isolated input 0-10 VDC or 4-20 mADC signal.

2) Run relay with an isolated set of Form C contacts.

3) Minimum of 2 programmable contacts.

4) Trip contacts (Form C).

5) VFD will accept an external trip contact and indicate so on the display.

6) Dedicated terminal blocks for interface with maintained remote start contacts.

7) Output signal proportional to output frequency (0-10 VDC or 4-20 mADC).

8) Output signal proportional to output current (0-10 VDC or 4-20 mADC).

9) Provided with communications chip to provide complete interface with the ATC control and automation system.

g. The VFD shall include the following protective features:

1) Lockable Fused disconnect (or breaker) rated for 100,000 AIC.

2) Electronic instantaneous overcurrent protection.

3) DC bus undervoltage protection.

4) DC bus overvoltage protection.

5) Ability to withstand output line-to-line short circuits without component failure.

6) Status indication via an LED display of the following protective functions:

a) DC Bus Undervoltage

b) Overcurrent

c) DC Bus Overvoltage

d) Controller Overtemperature

e) Overload

f) Overload Warning

g) Overfrequency and Phase Loss

h) A single light to indicate a VFD trip is not acceptable.

7) Overload capability shall be 110% of the inverter rating for (1) minute.

8) Selectable auto restart.

9) VFD will catch a motor spinning in the forward or reverse direction upon starting.

10) Upon loss of the input signal (4-20 mA), the drive will stop or go to preset speed.

h. Standard adjustments shall include:

1) Minimum frequency (4-60 Hz)

2) Maximum frequency (40-120 Hz)

3) Minimum of three (3) preset speeds (4-120 Hz) initiated by contact closures

4) Minimum of three (3) acceleration times (2-300 seconds)

5) Minimum of three (3) deceleration times (2-300 seconds)

6) Minimum speed dwell time (0-18 seconds)

7) Voltage boost (0-40V) for starting torque control

8) Adjustable Carrier frequency 700-8,000 Hz for motor noise reduction or flexible switching technology. This adjustment shall be without derating the drive or motor.

9) Current limit (70-120%)

10) Critical frequency avoidance ([2] bands with 10 Hz adjustable widths)

i. Door mounted operator controls and status indication from the LED display shall include:

1) Run/stop selection and LED indication (keypad or remote)

2) Speed control selection and LED indication

3) Forward/Reverse selection

4) Manual speed adjustment

5) Frequency meter

6) Motor RPM

7) Ammeter

8) Output voltage

9) Elapsed time meter

j. The keypad shall have an LED display. The reverse button and the programming functions may be locked out if desired.

5. The following list of options shall be included

a. Input lockable disconnect rated 100,000 AIC.

b. Thermal motor overcurrent relay.

c. Bypass which includes an output contactor electrically and mechanically interlocked with a bypass contactor, run relay including control logic, status lights and a thermal motor overcurrent relay. The complete bypass system and Inverter/Off/Bypass selector switch shall be packaged in a single VFD enclosure. The bypass shall include a starter.

d. Drives may be provided without bypass only when the drawing states that the specific drive shall not have bypass.

e. Electronics shall allow VFD to follow discrete increase speed and discrete decrease speed contact closures from a photohelic or similar device.

f. 120V control transformer and circuitry.

g. Output line reactors or output filters when the drive location and the motor are more then 100 feet apart.

h. Interior heaters shall be provided to maintain the minimum drive temperature when the drive is off.

i. A Customer Interlock Terminal Strip – provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. All external interlocks and start/stop contacts shall function with drive in hand, auto or bypass.

1) Damper control circuit shall be operable in the hand, auto and bypass.

6. Service

a. The VFD manufacturer shall provide a start-up service package for all VFDs provided. Service shall include inspector for final adjustment, operational checks, and a final report for record purposes. The service package shall include a (1) year parts and labor warranty and 2 year parts warranty each from date of written acceptance and be performed by local factory trained service engineers. The service center must be permanently located within (200) miles of the job site and able to provide 24-hour service.

7. Protection

a. The VFD shall be protected against damage at all times. The drive shall be stored in a clean, dry environment with temperature and

humidity within the range as specified by the drive manufacturer. Space heaters shall be energized controlled storage as recommended by the manufacturer. Storage space shall be environmentally controlled.

8. Factory Tests and Checks

   a. VFD power semiconductors and diodes shall be 100% inspected and tested, including load testing.

   b. Small signal semiconductors, resistors, capacitors and diodes shall be lot sampled. Testing shall include parameter, as well as functional characteristics.

   c. All printed circuit boards shall be tested under a temperature cycling (0°C to +65°C) 24-hour load test and then functionally tested via fault finder bench equipment prior to unit installation.

   d. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The VFD shall trip electronically without device failure.

   e. After all tests have been performed, each VFD shall undergo a 24-hour burn-in test. The drive shall be burned-in at 100% inductive or motor load for (24) hours without an unscheduled shutdown.

9. A (1) day training course for Owner's personnel shall be presented by representatives of the manufacturer at the jobsite.

PART 3 – EXECUTION

3.01 VFD INSTALLATION

A. Install in accordance with manufacturer recommendations, Contract Drawings, and reviewed submittals.

B. Install to meet the Local and State Electrical Code and so as to ensure easy accessibility for service, removal, or replacement of all components.

C. Provide supplemental steel, support, rods and hangers necessary to hang or mount VFDs.

D. Receive and inspect VFDs to ensure they are without defect. Defective or damaged VFDs shall be returned to the manufacturer.

E. Protect equipment to prevent damage from water, dirt, or accident. Protection shall include, but not be limited to, temporary plastic wrap to maintain equipment in original factory condition.

F. Wiring installation and handling shall be in accordance with manufacturer's recommendations.

G. Provide field testing (as described in Paragraph F, of this above Section).

3.02 FIELD TESTS AND CHECKS

A. Testing, checkout and start-up of the VFD equipment shall be performed under the technical direction of the manufacturer's service engineer. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.

B. The Contractor shall provide independent harmonic testing by an independent testing company. Provide readings with printouts of the harmonic current at each harmonic as well as the total voltage distortion. The following readings shall be provided:

1. At each point of common coupling:

    a. With all drives running with load

    b. With all drives off

2. At the power connection to each drive:

    a. With the drive running loaded

    b. With drive off

3. All the above data shall be submitted to the Architect for review. If these tests shown that the drives are not in compliance with the Specifications, the drive manufacturer shall make all changes required to comply with the Specifications at no cost to the Owner. If required, this could mean replacing the drives that are not in compliance.

4. A copy of all tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Owner for this record.

END OF SECTION 230514

SECTION 230516 – PIPE EXPANSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all necessary offsets, joints, expansion loops, compensators, anchors and guides so that no stress is placed on the piping systems or equipment due to thermal expansion.

B. Make proper provision for expansion and contraction in all parts of piping systems wherever possible by means of pipe bends, pipe offsets, swing connections or changes in direction of piping. Where piping network cannot be employed to absorb expansion and contraction in the piping systems, provide expansion joint compensators.

C. Expansion compensator elements shall be as specified herein and shall be selected by the manufacturer to withstand system pressure and temperature conditions and to absorb thermal expansion of the piping. Use of expansion compensators in non-accessible locations shall not be permitted.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Refer to Section 230598 – Mechanical Vibration Controls and Seismic Restraints for specific information related to and affecting this Section.

C. Refer to Section 230527 – Hangers and Supports.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASME B31.1 – Power Piping.

2. ASME B16.5 – Pipe Flanges and Flanged Fittings.

3. ASTM A 269 – Standard specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

4. EJMA (STDS) – Standards; Expansion Joint Manufacturers Association; 1993.

5. MIL-E-17814 – Expansion Joints, Pipe, Slip-Type, Packed

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional information.

C. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

2. Expansion Joints: Indicate maximum temperature and pressure rating and maximum expansion compensation.

D. Design Data: Indicate selection calculations.

E. Constant force hangers shall include the installed load, actual travel and total travel as a minimum.

F. Complete expansion, stress, and seismic calculations.

G. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures and external controls.

H. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors and guides.

I. Maintenance Data: Include adjustment instructions.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer: Company specializing in manufacturing products of the type specified in Part 2 – Products.

C. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

D. Welders: Certify in accordance with ASME.

1.08 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system and ASTM F708 for design and installation of pipe supports.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

1. Provide certificate of compliance from authority having jurisdiction, Indicating approval of welders.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. All expansion compensators shall be delivered in containers and shall be kept in a dry and protected area.

C. All anchors and guides, where exposed, shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.11 ENVIRONMENTAL

A. Do not paint or install expansion compensators, anchors or guides when:

1. Environmental conditions are outside the specific limitations of the referenced codes and/or manufacturer's recommendations.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 ENGINEERING SERVICES

A. The Contractor shall retain a registered Professional Engineer licensed to practice in the project state to review all loads imposed on the building structure and piping system to assure that no points are overstressed.

B. The maximum allowable stress shall be 15,000 psi for cold water, hot water, condensate, and steam and the maximum allowable stress shall be 2500 psi for generator exhaust piping if pipe material is low carbon steel A53 B or A106 B (Marks' Standard Handbook for Mechanical Engineers, Tenth Edition).

C. The Contractor shall submit shop drawings with calculations (with P.E. stamp) detailing the proposed anchor locations for review.

D. All anchor details and forces shall be submitted to the project structural engineer for review prior to any installation.

2.03 GENERAL

A. Make proper provision for expansion and contraction in all parts of piping systems:

1. Hot water

2. All under ground piping

3. Other piping

B. Wherever possible, provide expansion and contraction by means of pipe bends, pipe offsets, swing connections or changes in direction of piping.

C. Where piping network cannot be employed to absorb expansion and contraction in the piping systems, provide expansion joint compensators. Securely anchor all piping utilizing expansion loops and joints to the building structure with steel angles, properly braced and welded to the pipe.

D. Furnish and install expansion compensators for hot water piping, for all steam and condensate piping, steam vents and for all emergency generator engine exhaust.

E. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Expansion compensators larger than 4".

a. American Boa, Inc. or approved equal

2. Expansion compensators 4" and smaller.

a. American Boa, Inc. or approved equal

3. Guides

a. Keflex, Inc. or approved equal

4. Constant Force Hangers

a. ANVIL International, Inc. or approved equal

5. Flexible Expansion Loop

a. Metraflex (Metraloop) or approved equal

F. Use of expansion compensators in non-accessible locations shall not be permitted.

G. Temperature and pressure suitable for the service.

2.04 ANCHORS, GUIDES AND EXPANSION COMPENSATION

A. Expansion compensators: water 4" and smaller.

1. Water: Expansion joints shall be of the corrugated multi-ply bellows type formed hydraulically from metallic tubes with longitudinal welded seams. The middle plies shall be spiral wound and act as a labyrinth seal, and shall be of packless, leakproof, all-welded construction and maintenance free. Bellows shall be minimum 20 gauge up to 6" and 18 gauge for pipes

larger than 6". If joint will be exposed to salt (e.g., in manhole, direct buried, marine), material shall be Inconel 625, otherwise material shall be 321 stainless steel. End fittings shall match pipe schedule as specified. Compensators shall be equipped with setscrew and drain holes and shall have steel casing.

B. Flexible Expansion Loop (Seismic Applications):

1. All equipment, either rigidly mounted on vibration isolators, shall be attached to the piping system using flexible loops designed for seismic movement. Flexible loops shall be capable of movement in the X, Y, and Z planes and must completely isolate the equipment from the piping. System design engineer shall determine the amount of seismic movement required by the Uniform Building Code and/or other applicable codes.

2. All piping passing through building seismic joints shall contain a flexible expansion loop designed for seismic movement. Flexible loops shall be located at or near the building seismic joint. A vertical support hanger, located within 4 pipe diameters, shall be installed in each side of the flexible loop. Each hanger to be transversely and longitudinally braced per local codes. Seismic bracing shall not pass through building seismic joint and shall not connect or tie together different sides or parts of building structure. Flexible loops shall be capable of move in the X, Y and Z planes. System design engineer shall determine the required amount of seismic movement required by the Uniform Building Code and/or other applicable codes.

3. Flexible expansion/seismic loops shall consist of two flexible sections of hose and braid, two 90” elbows and a 180” return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180” return, and a drain/air release plug. Flexible loops shall impart not thrust loads to system support anchors or building structure. Flexible lops may be installed to accommodate both thermal and seismic motion. For steam service, lops must be installed with flexible legs horizontal to prevent condensate buildup. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings. Movement capabilities and location, relative to seismic separation, shall be determined by system design engineer and manufacturers recommendations.

C. Flexible Expansion Loop (Thermal Applications):

1. Provide flexible expansion loops of size and type noted on drawings. Flexible loops shall consist of two flexible sections of hose and braid, two 90” elbows, and a 180” return assembled in such a way that the piping

does not change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180" return, and a drain/air release plug. Flexible loops shall impart no thrust loads to system support anchors or building structure. Loops shall be installed in a neutral, pre-compressed or pre-extended condition as required for the application. For steam service, loops must be installed with flexible legs horizontal to prevent condensate buildup. Install and guide per manufacturer's recommendations. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings.

D. Constant Force Hangers

1. Constant force support hangers shall be provided for the emergency generator exhaust piping as determined by the stress and seismic analysis. Constant force hangers shall be pre-engineered to meet the loads and expansion for the vertical risers and off sets if any.

2. The total travel for constant support hangers will be equal to actual travel plus 20%. In no case will the difference between actual and total travel be less than 1 inch. The constant support hanger will have travel scales on both sides of the support frame to accommodate inspections.

3. Constant support hangers should be individually calibrated before shipment to support the exact load specified. The calibration record of constant support shall be maintained for a period of 20 years to assist the customer in any redesign of the piping system. Witness marks shall be stamped on the Load Adjustment Scale to establish factory calibration reference point.

4. No less than 10% of the adjustment should be provided either side of the calibrated load for plus or minus field adjustment. A load adjustment scale shall be provided to aid the field in accurate adjustment of loads. Additionally, the constant support should be designed so that load adjustments can be made without use of special tools and not have an impact on the travel capabilities of the supports.

5. Constant supports shall be furnished with travel stops which shall prevent upward and downward movement of the hanger. The travel stops will be factory installed so that the hanger lever is at the "cold" position. The travel stops will be of such design as to permit future re-engagement, even in the event the lever is at a position other than "cold", without having to make hanger adjustments.

6. Protection saddles shall be manufactured from alloy steel with weld-in center plate for use on the insulated high temperature piping similar to ANVIL International, Inc. Fig. 165A.

E. Guides

1. Pipe guides shall be of spider and sleeve type to insure multiplanar guiding and to allow complete insulation of the piping and shall be covered inside and outside with protective coating. Top half shall be removable.

2. Guides shall be installed in accordance with "Standards of the Expansion Compensators Mfrs. Assn.", latest edition.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All mains and risers having expansion offsets or compensators shall be securely anchored to the building construction in such a manner as to throw all expansion towards the offsets or joints.

B. All anchors shall be constructed from heavy steel and connected to the building construction. Anchors shall be furnished with turnbuckles or other suitable means for adjustment.

C. Contractor shall be responsible for any additional structural members that may be required for proper installation of hangers, anchors, guides and supports.

D. The method of securing the anchors to the building construction must be approved by the Architect prior to installation.

END OF SECTION 230516

SECTION 230519.20 – HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Secure all permits and local/state approvals for the installation of all components included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. ASME: American Society of Mechanical Engineers

C. ANSI: American National Standards Institute

1. B16.1: Cast Iron Pipe Flanges and Flanged Fittings

2. B16.3: Malleable Iron Threaded Fittings

3. B16.4: Cast Iron Threaded Fittings

4. B16.5: Pipe Flanges and Flanged Fittings

5. B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

6. B31.1: Power Piping

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. Product Data: Include steam/condensate specialties, pipe fittings and accessories. Provide manufacturers catalogue information.

D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

1.08 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of steam and condensate piping systems including specialties.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Provide temporary end caps and closures piping and fittings. Maintain in place until installation.

C. Protect piping systems and specialties from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.11 ENVIRONMENTAL

A. Do not install equipment when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. Provide thermometers and gauges:

1. At each pump

2. At each boiler

3. At each PRV station

4. As shown on the drawings

5. As required

B. Thermometers and pressure gauges shall be provided for the above described equipment regardless of pipe size. If pipe size is such that the installation of wells or taps is not feasible, then oversized pipe to accommodate the above installation requirements.

C. No products containing mercury will be acceptable.

2.03 THERMOMETERS, GAUGES AND PRESSURE/TEMPERATURE TAPS

A. Acceptable manufacturers subject to compliance with the specifications.

1. Weksler or approved equal

B. All thermometers in liquids shall have separable sockets.

C. Thermometers shall be with glass fronts, aluminum or phenol cases, and adjustable as required for ready reading from the floor.

D. All thermometers shall use non-toxic liquid filled magnifying lens front tubes.

E. All thermometers shall have 9" scales and 12" cases.

F. All thermometers shall be accurate to ±1% of scale range.

G. Thermometer ranges shall be selected so that the normal operating range of each will occur in the middle half of the total range and so that under minimum and maximum conditions thermometers will not be harmed.

2.04 THERMOMETER WELL

A. 304 or 316 stainless steel tapered shank.

B. Where installed in insulated systems provide extended neck.

C. 3/4 inch NPT process connection; 1/2 inch NPT instrument connection and nominal 1/4 inch bore.

2.05 GAUGES

A. Acceptable manufacturers subject to compliance with the specifications.

1. Weksler or approved equal

B. Except for the automatic temperature control system, gauges shall be constructed with bourdon type bronze tubes, stainless steel movements, white dials, black micrometer adjustable points, aluminum or phenol surface mounted beaded cases, matching aluminum or phenol screwed rings and bottom connections. All gauges shall have 4 1/2" diameter cases. All gauges shall be accurate to 1% of scale range.

C. Gauge ranges shall be selected such that the normal operating range of each will occur in the center of the total range and under minimum and maximum conditions no gauge will be harmed.

D. All gauges shall be provided with needle valves

1. Barstock needle Valves shall be equal to:

a. Crane or approved equal

E. Gauges installed in pump discharge piping shall be provided with snubbers and steam with siphons equal to Ray.

2.06 PRESSURE DIFFERENTIAL GAUGE

A. Acceptable manufacturers subject to compliance with the specifications.

1. Similar to ITT Barton Instruments Company.

2.07 RELIEF VALVES, PRESSURE REDUCING VALVES

A. Acceptable manufacturers subject to compliance with the specifications.

1. Bell and Gossett, ITT or approved equal.

2.08 PRESSURE/TEMPERATURE TAPS

A. Acceptable manufacturers subject to compliance with the specifications.

1. Sisco P/T Plugs or approved equal.

B. All pressure/temperature taps shall have a solid brass 1/4" or 1/2" NPT fitting (test plug).

C. Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d. Valve core shall be neoprene for temperatures 60°F to 200°F, nordel to 350°F, and shall be rated zero leakage from vacuum to 1000 psig.

D. The Contractor shall also furnish the following:

1. Pressure gauge adapters with 1/16" and 1/8" o.d. probe

2. 5" stem pocket testing thermometers for 25° to 125°F (chilled water)

3. 5" stem pocket testing thermometers 0° to 220°F (hot water)

4. 5" stem pocket testing thermometers 50° to 500°F (temperatures above 220°F).

5. A Master test kit which shall contain

a. A 2 1/2" test gauge of suitable range

b. A gauge adapter with 1/16" and 1/8" o.d. probe

c. A 5" stem pocket testing thermometers 0° to 220°F

d. A 5" stem pocket testing thermometers 50° to 550°F).

2.09 PRESSURE DIFFERENTIAL GAUGE

A. Dual rupture proof liquid filled bellows having integral temperature compensation.

B. Designed to withstand repeated overranges equal to the working pressure of the instrument housing without causing a calibration change. Gauge and components shall be suitable for a working pressure of 200 psig and a water temperature of 200 degrees F.

C. Motion transmission is by a hermetically sealed torque tube, no lubrication required.

D. Dial shall be a minimum of 6 inches round. Indicator case shall be fabricated from die-cast aluminum and finished in black epoxy paint. The indicating scale shall be graduated uniformly for measurement of differential pressure.

E. Scale shall be calibrated in 1 psig increments. Full scale range shall be from 0 to 25 psig.

F. The indicating mechanism shall consist of a precision-made, jeweled, rotary movement. It multiplies rotation of the torque tube through a gear and pinion to the indicating pointer. The indicating pointer shall traverse a 270 degree arc. The movement shall have micrometer screws for convenient zero and range adjustments. Zero and range adjustments shall be made without removing the scale plate or the pointer. The rotary movement and the pointer should be fully protected from overrange in either direction.

G. Accuracy shall be within 2 percent of the full scale differential pressure range when operating at or below 200 psig.

H. A three-valve manifold shall be used. The manifold shall provide two block valves and a bypass valve for installation and zero check. Valves shall also be provided on the instrument housings for bleeding or venting.

I. Two 10 foot neoprene hoses shall be included with the differential pressure gauge. Hoses shall be equipped with 1/4 inch NPT male fittings for connecting to

the manifold. The other end of the hoses shall have an adaptor to mate with the pressure temperature tap.

J. The differential pressure gauge, valve manifold, bleed valves, hoses and instruction booklet shall all be placed in a plastic carrying case. The gauge indicator and manifold shall be permanently mounted on the base of the case. The case cover shall be equipped with a handle fastened to the base with toggle type latches.

K. Differential pressure gauge shall be similar to ITT Barton Model 247A.

2.10 RELIEF VALVES

A. Relief valve body shall be of iron or bronze construction.

B. ASME rated direct spring loaded type, level operated, non-adjustable factory set discharge pressure.

C. For expansion tank application, select system relief valve pressure setting and equipment relief valve pressure setting as indicated on mechanical contract drawings.

D. Pressure relief valve shall be suitable for maximum system operating pressure and temperature.

2.11 PRESSURE REDUCING VALVE

A. Pressure reducing valve shall be bronze or iron body construction, with renewable stainless steel seat, and high temperature resisting diaphragm, direct acting, spring loaded, suitable for inlet pressure of 150 psi.

B. Built in stops shall protect diaphragm against sudden shock waves that could stretch or tear the diaphragm.

C. Provide a cartridge seat assembly with a seat washer and monel strainer for quick cleaning and replacement.

2.12 AIR VENTING AND DRAINAGE

A. Manual air vent.

1. Provide hose end ball valves, (minimum size 1/2" with chains and caps), or larger where shown or required by the service.

2. See HVAC Valve specification

B. Automatic air vent.

1. Acceptable manufactures subject to compliance with the specifications:

a. Armstrong or approved equal.

2. Float type with isolating valve, cast iron body, stainless steel float, stainless steel valve, and valve seat. Suitable for 300 psig operating pressure and 300 degrees F system temperature.

3. Vents shall be designed to eliminate air from the system automatically without permitting the passage of water.

4. Minimum size shall be ¾" or as indicated or required.

5. Similar to Armstrong Model 1-AV.

C. Drains

1. Provide ball valves with caped hose connections, (minimum size 3/4"), or larger where shown or required by the service.

2. See HVAC Valve specification

PART 3 – EXECUTION

3.01 THERMOMETER INSTALLATION

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Shall be turned as such to be readily visible from the operating floor.

C. Thermometers subject to vibration or physical damage shall be adequately supported and protected.

3.02 THERMOMETER WELL

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

3.03 PRESSURE RELIEF VALVE

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

3.04 PRESSURE REDUCING VALVE

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

3.05 PRESSURE DIFFERENTIAL GAUGE

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Provide differential pressure gauge package to user after system balancing.

3.06 GAUGE INSTALLATION

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Shall be turned as such to be readily visible from the operating floor.

C. If the gauge is more than 8'-0" above the floor or cannot otherwise be made readily readable, extended pipe connections gauge to a readable location.

D. Gauges subject to vibration or physical damage shall be adequately supported and protected.

3.07 PRESSURE/TEMPERATURE TAPS INSTALLATION

A. Shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Provide pressure taps wells for all in-duct or in-box water coils.

3.08 AIR VENTING INSTALLATION

A. Manual air vent

1. Provide all high points in closed water piping systems shall be relieved of air through accessible manual vents on the high points of the pipe lines and at the equipment. Vent valves on piping and equipment shall be 1/2" ball valves with chains and caps and with discharge pipes to convenient points for catching discharge.

2. Provide access doors to all vents.

B. Automatic air vent

1. Provide as indicates and at expansion tank connection to main pipe.

2. Pipe to spill over floor drain or sink.

3.09 DRAINAGE

A. Grade all piping for drainage through equipment or through accessible drain valves so that system can be conveniently freed of water by gravity flow.

B. Provide drains from air handling units and from air intake and other intake and exhaust plenums with traps. Traps shall be a minimum of 4", unless the static pressure requires additional trap depth. Discharge drains to nearest floor drain.

END OF SECTION 230519

SECTION 230523 – HVAC VALVES AND STRAINERS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all shut-off, check, balancing and other type valves and strainers as shown and as required to make a complete and operational system.

B. Provide isolation valves at all drains, piping mains and branches at all piping systems, equipment, risers and before and after all control valves.

C. Secure all permits and local/state approval for the installation of all components included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. MSS SP-67 – Butterfly Valves Manufacturers Standardization Society of the Valve and Fittings Industry.

2. MSS SP-69 – Pipe Hangers and Supports – Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry.

3. MSS SP –70 - Cast Iron Gate Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.

4. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.

5. MSS SP-80 – Bronze Gate, Globe, Angle and check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry.

6. MSS SP-85 – Cast Iron Globe & Angles Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.

7. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry.

8. MSS SP-11- Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry.

9. UL 1479 – Standard for Fire Tests of Through-Penetration Firestops; Underwriters Laboratories Inc.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. Product Data: Include data on valve materials, pressure class, construction, dimensions and ratings. Provide manufacturers catalogue information. All valves of one type shall be by one specific manufacturer.

D. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable designation.

E. Manufacturer’s Installation Instructions: Indicate hanging and support methods, joining procedures.

F. Project Record Documents: Record actual locations of all valves and valve tag numbers.

G. Maintenance Data: Include spare parts list and exploded valve assembly views.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer: Company specializing in manufacturing valve and strainer products specified in this section, with documented experience.

C. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

E. All valves and strainers shall contain manufacturer's name and pressure class marked on the valve body.

1.08 REGULATORY REQUIREMENTS

A. Perform Work in accordance with all State and Local codes.

B. Conform to all State and Local code for installation of boiler safety valves and backflow prevention devices.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. One valve manufacturer's figure numbers are listed; valves from other manufacturers listed in the list of acceptable manufacturers will be accepted.

B. Provide all shutoff, check, balancing and other types of valves and strainers as shown on the drawings and required for proper operation, maintenance, isolation and safety of all piping systems.

C. Provide isolation valves at all drains and piping mains and branches for all water piping, at all equipment connections and before and after automatic control valves.

D. Face-to-face and end-to-end dimensions of flanged iron body valve shall conform to ANSI B16.10. Design workmanship, materials and testing shall conform to MSS-SP-70 (gates), MSS-SP-71 (swing checks) and MSS-SP-85 (globe).

E. End-to-end dimensions of grooved ductile iron body valves shall conform to the latest published dimensions.

F. Each valve body and seat shall be tested by the manufacturer and shall carry a permanently affixed indication that test have been successfully completed, with copy of the test data furnished.

G. All valves or strainers of the same type shall be of the same manufacturer. Before purchasing any valve, the Contractor shall submit for approval the name of the manufacturer, the figure number which he proposes to furnish and engineering data on each figure number. For acceptable manufacturers, see schedules herein.

H. Valves/Strainers in grooved piping systems may be grooved.

I. All valves used for balancing purposes, shall have memory stops.

J. Provide handwheels for all manually operated valves equipped with gear operators. Handwheels shall accept bolt-on chain operators.

K. Provide chain operators for all gear operated valves located 7'-0" above floor or higher.

L. Size valve handwheels for not more than 80 lbs. pull on one side of the handwheel to effect tight closure. Where the manufacturer's standard handwheel size is not large enough to accomplish this, provide a gear operator.

M. Valve bonnets and gear operators shall be designed to withstand all forces which may be applied to the handwheels, including those from chain operators.

N. Valves and strainers shall be rated in accordance with the "Spec. Class No." Specified for that system.

2.03 ACCEPTABLE MANUFACTURERS CONTINGENT ON COMPLIANCE WITH THE SPECIFICATIONS

A. Butterfly Valves

1. High Performance

a. Jamesbury or approved equal.

2. Soft Seated

a. Bray or approved equal.

B. Flow Control Balancing Valves

1. Tour & Andersson / TA Hydronics or approved equal.

C. Check Valves

1. Swing

a. Walworth or approved equal.

2. Silent

a. Mueller Steam Specialty or approved equal.

D. Vacuum Breakers

1. Sarco or approved equal.

E. Ball Valves

1. Apollo or approved equal.

F. Strainers

1. Y Type

a. Elliot or approved equal.

2.04 VALVE CHART

Service	Minimum Class and Material			Joints	
	2" and Less	**2½" to 12"**	**14" & Up**	**2" and Less**	**2½" & Up**
Hot water supply and return	MSS Class 150 Bronze	MSS Class 125 Cast Iron	ANSI Class 150 Cast Steel	Threaded	Flanged
Makeup and fill	MSS Class 150 Bronze	MSS Class 125 Cast Iron	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*
Miscellaneous drains to 2"	MSS Class 150 Bronze			Threaded	
Refrigerant system	MSS Class 150 Bronze			Silver Brazed	Flanged
Other piping	MSS Class 150 Bronze	MSS Class 125 Cast Iron	ANSI Class 150 Cast Steel	Threaded	Flanged or Grooved*

* Grooved piping systems of standard wall or lighter shall be **roll** grooved according to Victaulic roll groove specification standards. On piping heavier than standard wall, cut grooving required per Victaulic **cut** groove specification standards.

2.05 BALL VALVE

A. Up to 2" (for water 200°F and below)

1. Full port

2. All stainless steel ball and stem

3. Extended stem for insulation

4. Two piece bronze body

5. 600 PSIG WOG

6. 250 PSIG steam trim

7. Threaded

    a. Similar to Apollo Fig. 77-140-64

8. Soldered

    a. Similar to Apollo Fig. 77-240-64

2.06 SWING CHECK VALVES

A. Access to Elements

1. Up to 2" except as noted: Screw-in caps

2. 2" to 2-1/2": Bolted or coupled covers

B. Water (Except at Pump Discharge and as Noted)

1. Up to 2"

    a. Bronze body, screwed ends, regrind bronze disc.

        1) Class 150: Similar to NIBCO Fig. T-433

    b. Bronze body, screwed ends, regrind bronze disc.

        1) Class 200: Similar to NIBCO Fig. T-453

    c. Bronze body, screwed ends, regrind bronze disc.

        1) Class 300: Similar to NIBCO Fig. T-473

2. 2 1/2" and Up

    a. Iron body, regrind/renew bronze disc, flanged.

        1) Class 125: Similar to NIBCO Fig. F-918

    b. Iron body, regrind/renew bronze disc, flanged.

        1) Class 250: Similar to NIBCO Fig. E-968

2.07 SILENT CHECK VALVES

A. Spring Loaded, Globe Type

1. Screwed

a. Similar to Mueller 303 BP.

2. Cast steel body, stainless steel trim for valves above 250 psi.

3. Flanged

a. Similar to Mueller 105 MAP.

4. Grooved

a. Victaulic Series 716 (Sizes to 12”)

2.08 FLOW CONTROL BALANCING VALVES

A. Balancing valves shall be installed, as shown on the drawings and as required, to ensure the accurate balancing of all flows in the hydronic heating and cooling systems. The balancing shall meet the specified water flows with a maximum tolerance of ±5%.

B. Valves shall be of the "Y" pattern globe style design and must offer a minimum of (4) full rotations of the handwheel for accurate adjustment and for precise flow control.

C. Valves shall exhibit an accuracy of ±5% within the normal operating range.

D. Valves shall have integral self-sealing metering ports for measuring differential pressure, flow rates and temperature. Ports shall be protected with individual threaded caps.

E. Valves must offer 100% positive, leakproof shutoff against the same fluid pressure as the valve body rating to a nominal value of 300°F (230°F if grooved) at 250 psi.

F. Valves sizes 1/2" to 2" similar to TA (STAD/S) shall have a digital handwheel for positioning accuracy. Provide a transparent dust/paint cover to prevent destruction of the digits during construction. Sizes 2 1/2" to 12" similar to TA (STAF/G) shall have a numerical vernier sleeve for position readout.

G. All balancing valves must offer a hidden memory feature to prevent unauthorized adjustment and to ensure a return to the original setting after shutoff.

H. All balancing valves shall comply with international quality standard ISO 9001.

I. Valves larger than 12": use lubricated plug valve.

J. All balancing valves size 1/2" to 2" shall be manufactured from pressure diecast dezincification resistant AMETAL copper alloy which does not require dielectric fittings. Valve bodies size 2 1/2" to 12" shall be manufactured from a cast iron equivalent to ASTM 35B with all wetted, moving parts of dezincification resistant AMETAL copper alloy.

K. This valve may be 1/2” with a reducer and increaser to 3/4” pipe as required for balancing. This is the only type of valve that can be 1/2”.

2.09 BUTTERFLY VALVES

A. High Performance (For services above 150°F and or above 150 PSIG)

1. Sizes 2 1/2" and larger shall be an ANSI class valve equal to or greater than the class specified for the service but in no case be less than ANSI Class 150.

2. Body carbon steel with a fully lugged body suitable for bi-directional tight shut off to full rated pressure without a downstream flange.

3. Valve shall have no disk contact with the seat when in the open position or any intermediate position. Seal suitable for the operating service and operating temperature plus 50°F.

4. Bearings shall be constructed of SS/Graphite.

5. Seats shall be Xtreme (X).

6. Valve shall be of the double off-set design.

7. The disk shall be 316 stainless steel.

8. The shaft shall be 17-4 PH stainless steel.

9. The disk pin shall be 316 or 17-4 stainless steel.

10. Seat retainer ring fasteners shall not in contact with system fluid.

11. The disk shall be stainless steel.

a. Operator

1) Lever Operator for Valve Sizes Less than 6" except steam service.

a) Infinite Positioner: Ductile iron ASTM A536. Provide operator with position indicator which shall also indicate "open" and "closed" position. Provide memory stop.

2) Gear Operator for Valve Sizes 6" and Greater as well as all sizes for steam service.

a) Cast iron ASTM A126 Class B housing. Bronze shaft bearings. Steel ASTM A216 worm gear. Ductile iron ASTM A536 segment gear. Ductile iron ASTM A536 handwheel. Minimum handwheel diameter shall be 12" for valve sizes through 20", and 18" for valves larger than 20". Provide operator with position indicator and shall also indicate "open" and "closed" position. Provide memory stop. All gearing shall be enclosed in a housing.

b. Similar to Neles-Jamesbury series 815 High performance wafer sphere butterfly valve.

B. Soft seated (For services below 150°F)

1. Sizes 2 1/2" and Larger: Suitable for bi-directional dead end service (full pressure rating of valve) with downstream flange removed.

2. Minimum 175 psig bubble tight shut-off with flow in either direction. Valve shall comply with MSS-SP67, or MSS SP-68, unless more stringent requirements are specified.

3. Each valve shall be hydrostatically tested at the factory to 110% of pressure rating and proven bubble tight for a minimum of (1) minute.

a. Body:

1) Cast iron ASTM A126 minimum Class B, ductile iron ASTM A536, carbon steel ASTM A515 or A516 minimum grade 70, or cast carbon steel ASTM A216 WCB. Fully lugged body drilled and tapped for ANSI B16.5 Class 150 flanges.

2) Ductile iron ASTM A536. Grooved end body. (Sizes 14” through 24” supplied with AGS grooved ends.)

4. Disc: Valve disc shall be of a streamline design for low pressure drop and resistance to cavitation. Electroless nickel coated ductile iron ASTM A536, aluminum bronze ASTM B1011/1011M, or 316 stainless steel ASTM A351 CF8M. Disc shall be machined and polished to minimize seating torque and extend seat life. Disc shall be attached to shaft by stainless steel screws, pins or integral key. On valves 12” and smaller, the disc shall be offset from the stem centerline to provide continuous 360-degree seating. Disc flutter is not acceptable.

   a. Shaft: One-piece through shaft or 2-piece shaft design. Shaft shall be blowout proof and not rely on operator for retention. Shall be 316 stainless steel ASTM A276 type 316 or 17-4 PH stainless steel ASTM A564 Type 630. Seal by valve seat with secondary seal "O" ring or adjustable packing gland with Teflon packing.

   b. Shaft Bushings: Shaft bushings at each end of seat. Bushings shall be reinforced Teflon, fiberglass with TFE lining, 316 stainless steel backed TFE, low friction bronze ASTM B438 or stainless steel.

   c. Seat: Pressure responsive for valves 12” and smaller. Reinforced cartridge type, or seat with a mechanically attached retaining ring. With ethylene propylene diener monomer (EPDM) seat.

   d. Operator

      1) Lever Operator for Valves Sizes Less Than 6".

         a) Infinite Positioner: Ductile iron ASTM A536. Provide operator with position indicator which shall also indicate "open" and "closed" position. Provide memory stop.

      2) Gear Operator for Valve Sizes 6" and Greater

         a) Cast iron ASTM A126 Class B housing. Bronze shaft bearings. Steel ASTM A216 worm gear. Ductile iron ASTM A536 segment gear. Ductile iron ASTM A536 handwheel. Minimum handwheel diameter shall be 12" for valve sizes through 20", and 18" for valves larger than 20". Provide operator with position indicator and shall also indicate "open" and "closed" position. Provide memory stop. All gearing shall be enclosed in a housing.

e. Similar to Bray Series 31H for valves through 20".

f. Similar to Bray Series 36 for valves 24” through 48" body full Flange except 150 PSIG. Above 150 PSIG, use high performance fuel ANSI valve.

g. Grooved End Butterfly Valves:

1) Steel Pipe Sizes 2” through 12”: Ductile iron grooved end body suitable for bubble-tight shutoff, bi-directional, dead-end service at full rated pressure. Electroless nickel-plated ductile iron disc offset from the stem centerline to provide continuous 360 degree seating. Blowout-proof 416 stainless steel stem, TFE lined fiberglass bearings, EPDM seat and seal material, lever handle or gear operator with handwheel and memory stop, rated at 300 psi, 230°F. Similar to Victaulic Vic-300 MasterSeal.

2) Steel Pipe Sizes 14” through 24”: Ductile iron body and disc, PPS coated, two piece 17-4 PH stainless steel stem design, EPDM seat and seal material, reinforced PTFE bearings and gear operator with handwheel and memory stop, rated at 175 psi, 230°F, AGS grooved ends, suitable for bubble-tight shutoff, bi-directional, dead-end service at full rated pressure. Similar to Victaulic Series W709.

3) Copper Tubing Sizes 2-1/2” through 6”: Bronze body, copper tubing sized grooved ends, elastomer encapsulated ductile iron disc, integrally cast stem, lever handle or gear operator with handwheel and memory stop, 300 psi, 230°F, suitable for bubble-tight shutoff, bi-directional, dead-end service at full rated pressure. Similar to Victaulic Series 608.

2.10 STRAINERS

A. General

1. Screwed ends to 2", flanged or grooved ends 2 1/2" and up.

2. Body

a. 125 lbs. WSP Class, cast iron up to 100 psi. Note cast brass may be used for copper piping systems.

3. Screen

a. 316 Stainless steel or Monel.

b. Free area not less than 2.5 times inlet area.

c. Perforations (unless noted otherwise)

1) Water

a) Up to 4": 1/16"
b) 6" & 8": 1/8"
c) 10" & Up: 5/32"

d. Construction

1) Screen wire gauge to suit size and service.
2) Reinforced.

B. Y Type

1. Screwed

a. Faced cap, straight thread and gasket.

b. Similar to Mueller Steam Specialty Muessco #251-FC.

c. For 125 psig copper systems similar to Mueller Steam Specialty 358S.

d. For 250 psig copper systems similar to Mueller Steam Specialty 352M.

2. Grooved

a. Coupled cover.

b. Victaulic Style 732.

3. Flanged

a. Bolted cover.

b. Similar to Mueller Steam Specialty Muessco #751 or #752.

4. Diesel Oil

a. Cast Iron Body ASTM A-126 Hydrostatically tested at 300 PSIG

1) Screen size shall be 40 MESH note for #4 or #6 use 3/64” perforations.

2) Similar to Preferred utilities MFG Corp. No. 50.

5. Condenser Water

a. Up to 6" IPS

1) Cast iron body basket strainer.

2) Bolted cover and bronze plug valve.

3) Similar to Zurn Series 560FES.

PART 3 – INSTALLATION OF VALVES AND STRAINERS

3.01 VALVES

A. Provide valves as noted and as indicated on drawings.

B. Shutoff Valves

1. Inlets and outlets of equipment.

2. All branch connections to mains.

3. As noted.

C. Check Valves

1. Pump Discharges: Silent check valves

2. Other Locations: Types as noted

D. Valves

1. Accessible, but no valve handles pointing down below horizontal position. Removable without separating or lifting piping in which valves are installed. Provide cap screws on threaded bodies. Where abutting flanged strainers or similar devices, position valve with respect to device so as to permit removal of bolts.

E. Drain valves at low points in water piping and where noted.

1. In Equipment Rooms

    a. Up to 3" Pipe: 3/4" ball valve
    b. 4" to 8" Pipe: 1 1/2" ball valve
    c.

2. 1/2" drain valve with capped hose connection except in equipment rooms.

F. Where possible install butterfly valves with stems in horizontal position and with the low point of disc opening with the direction of flow.

G. Provide stem extensions on all valves such that hand wheel or lever extends beyond insulation and is operable.

H. Note soft seated butterfly valves can only be used in water services below 150°F. All butterfly valves in water services above 150°F shall be of the high performance type.

I. Use flow control balancing valves for throttling service.

J. Provide spring loaded silent type check valves on discharge of pumps.

K. Install swing check valves in horizontal position only.

L. Provide drain valves at low points between valves, low points of piping system and at equipment.

M. Threaded valves shall be provided with a union adjacent to and downstream of valve.

N. Grooved end valves shall be provided with grooved joint couplings.

O. Butterfly valves shall not be used for balancing.

P. Remove internal cartridges from constant flow valves during flushing and cleaning.

Q. Butterfly valves shall be installed between weld neck flanges or with grooved joint couplings of the same manufacturer only.

R. Provide chain operated sheaves for valves in exposed areas located more than 7'-0" from floor.

S. Pressure Relief Valves

1. Provide at:

a. Cooling coil side of isolation valve.

b. Other locations as noted.

2. Pipe to spill over floor drain or slop sink unless otherwise indicated.

3.02 STRAINERS

A. Valved and provided with hose connection chain and cap.

B. Line size, except as noted.

C. Locate upstream of:

1. Pumps

2. Automatic control valves 2" and larger

3. Pressure reducing valves

4. Other equipment as noted

5. As indicated

END OF SECTION 230523

SECTION 230529 – HANGERS AND SUPPORTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all hangers, supports and assemblies for all parts of the mechanical systems. This shall include all piping, ducts and equipment specified in this Division and as shown on the drawings

B. All materials shall be new and manufactured for the specific purpose of supporting systems, equipment, pipes, ducts, conduits and accessories.

C. All system components shall be installed in accordance with local codes including seismic isolation as required and specified under Section 230598.

D. Refer to Section 230516 Pipe Expansion and closely coordinate with this work.

E. Secure all permits and local/state approval for the components as specified and included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Refer to Section 230598 – Mechanical Vibration Controls and Seismic Restraints for specified information related to and affecting this section.

C. Refer to Section 230516 – PIPE EXPANSION.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

1. Material standards shall be as specified or detailed hereinafter and as following:

2. ASME B31.9 – Building Services Piping, The American Society of Mechanical Engineers.

3. ASME B31.1 – power piping.

4. ASHRAE Systems and Equipment Handbook.

5. ASTM F 708 – Standard Practice for Design and Installation of Rigid Pipe Hangers.

6. MSS SP-58 – Pipe Hangers and Supports – Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry.

7. MSS SP-69 – Pipe Hangers and Supports – Selection and Application; Manufacturers Standardization Society of the Valve Fittings Industry.

8. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry.

9. NFPA-13 – Installation of Sprinkler Systems

10. MSS-SP-127-2001 – Bracing for Piping Systems.

1.05 SYSTEM DESCRIPTION

A. In addition to special hangers and supports specified elsewhere in this Section and shown on the drawings for ducts, piping and equipment furnish and install safe and substantial means of support for all parts of the mechanical systems. Shop drawings shall be submitted for review and approval for all supports. All piping, ductwork, exhaust pipe and breeching hangers and supports in all mechanical rooms, penthouses and energy plant shall be installed with vibration isolators and Seismic restraints. This requirement is mandatory and shall be strictly enforced.

B. All piping shall be hung to true alignment, using appropriate and substantial hanger arrangements. Wire and strap hangers will not be permitted. Hangers shall be located so that piping and hangers will be clear of other piping, hangers, conduits, lighting and other obstructions.

C. The hanging and supporting of piping and equipment shall conform to recommendations of the manufacturers of same and American National Standard, ANSI/MSS SP-58 and SP-69 latest edition, except where requirements of this specification exceed the above referenced Standards.

1.06 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for Additional Requirements.

C. All brackets and hangers shall be submitted for review. Include the method of hanging and supporting all piping, ductwork and equipment.

D. The Architect is to be notified when the first bracket is assembled so that the installation can be reviewed in the field.

E. Provide location of all inserts to be used for hanging ductwork, piping and equipment and the weight of all components (including water weight).

1.07 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.08 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01

B. Manufacturer: Company specializing in manufacturing products of the type specified in Part 2 – Products.

C. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

D. Welders: Certify in accordance with ASME.

1.09 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system and supports.

B. Conform to ASME B31.1 code for power piping.

C. All applicable seismic codes.

D. ASTM F708 for design and installation of pipe hangers..

E. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations

1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.10 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. All hangers and supports shall be delivered in containers and shall be kept in a dry and protected area.

C. All exposed hangers, supports, etc. shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

1.11 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.12 ENVIRONMENTAL

A. Do not paint or install inserts, hangers and/or supports when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 – PRODUCTS

2.01 BUY AMERICA POLICY

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. Pipe supports shall be of type and figure number as specified.

B. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

1. Pipe Hangers

a. Carpenter & Patterson or approved equal.

2. Constant Force Hangers.

a. Anvill International, Inc. or approved equal.

3. Channel Support Systems

a. B-Line Systems, Inc. or approved equal.

4. Thermal-Hanger Shield Inserts

a. Carpenter & Patterson, Inc. or approved equal.

2.03 PIPE HANGERS

A. Bracket assemblies for supporting piping are to be fabricated by welding and all irregular surfaces are to be smoothed up by grinding. Shop drawings shall be submitted for review for each type bracket. The Architect is to be notified when the first bracket is assembled so that installation can be reviewed in the field. Exposed hangers, supports and brackets are to be given (2) coats of rust resistant paint of the color as selected by the Architect. Additionally, provide for Architect's review, the following:

1. Location of all inserts to be used for hanging ductwork and piping where applicable and the weight of such pipe or equipment to be hung, including the weight of water, valves and insulation.

2. Method of hanging and support of all piping, ducts and other equipment.

B. All pipe supports shall be of type and arrangement as hereinafter specified. They shall be so arranged as to prevent excessive bending stresses between supports.

C. All bracket clamp and rod sizes indicated in this specification are minimum sizes only. This Section shall be responsible for structural integrity of all supports. All structural hanging materials shall have a safety factor of (5) built in. Beam clamps shall be 2-sided steel clamps designed to firmly attach to the flange of the beam with the load directed downward on the centerline of the beam web. Beam clamps shall be similar to B-Line #B3055, or approved equal.

D. Other forms of hangers and supports shall be used to accommodate special or unusual job conditions or conditions not covered herein, subject to the approval of the Architect. When special conditions require the use of concrete inserts which are not "built in", such inserts may be used in locations approved by the Architect and shall be Phillips "Red Head" or approved equal. Explosive powder studs or detonator assisted studs or anchors will not be permitted.

E. All pipes shall be hung free of dependence on pipe sleeves for support.

F. All auxiliary steel required for pipe, duct and equipment supports shall be furnished and installed by the Mechanical Contractor.

G. Threaded pipe, chains, wire and perforated straps will not be accepted. No piping shall be supported from ductwork, conduit or other piping. All system components and equipment shall be independently supported. Distribute hangers on parallel piping to avoid overloading of structure.

H. Roller type supports shall be used for pipes subject to axial movement . They shall be braced so that movement occurs in roller rather than support rods. This requirement shall apply to piping 2 1/2" and up.

I. Constant force support hangers shall be provided for the emergency generator exhaust piping as determined by the stress and seismic analysis. Constant force hangers shall be similar to Anvil International, Inc. and they shall be pre-engineered to meet the loads and expansion for the vertical risers and off sets if any.

J. Hangers and supports used for systems exposed to weather shall be hot dipped galvanized in accordance with ASTM A153-73 or A123. Rods and nuts shall be electro-galvanized.

K. All horizontal water, drain, waste, vent and rainwater piping shall be hung with clevis steel hangers similar to B-Line #B3100. Groups of pipes in the same horizontal plane and with the same pitch may be supported on B-Line #3160 gang hangers. Wall brackets similar to shall be B-Line #B3066 and #B3077.

L. All pipes which are hung so that the centerline of the pipe is less than 10" below the point of suspension of the hanger rod and all hydronic hot water piping shall be supported on roller hangers similar to B-Line #B3110.

M. Unless otherwise noted, maximum hydronic pipe hanger spacing shall not exceed the recommendations of the pipe manufacturer and the following:

1. For 1/2" copper and steel pipe: 5'-0" o.c.

2. For pipe 3/4" to 1 1/2": 8'-0" o.c.

3. For pipe 2" to 8": 10'-0" o.c.

4. In addition, hangers shall be installed within 2'-0" of each change in direction and on each side of valves 3" in size and up.

N. Hanger rods shall be of steel and not less in diameter than:

1. For pipe 2" and under: 3/8"

2. For pipe 2 1/2" and 3": 1/2"

3. For pipe 4" and 5": 5/8"

4. For pipe 6": 3/4"

O. Insulated steel piping 2 1/2" and up shall be fitted with steel pipe covering protection saddles similar to B-Line #B3163 and of the same depth as the specified insulation. Saddles shall be tack welded to the pipe and filled with loose insulation. Standard length saddles may be cut in (2) equal sections for attachment to pipes 6” diameter and under.

P. Insulated piping 2" and under shall be fitted with 16 gauge steel covering protectors at each hanger location similar to B-Line #B3151.

Q. All vertical piping shall be supported with steel riser clamps similar to B-Line #B3773. Such clamps on copper tubing shall be applied over couplings only.

R. All pipes suspended at an elbow shall be hung using plate lugs similar to Grinnell #HS.53 with forged steel clevis similar to B-Line #B3201.

S. Spring hanger locations shall be provided as specified herein, under vibration isolation, and shall be Grinnell, pre-engineered to meet loads and movements in accordance with ANSI B.31.1.10, where applicable.

T. Drop rods for hangers may be used wherever possible and shall be installed prior to slabs being poured. Drop rod details shall be submitted to the Architect and Engineer for review.

2.04 DUCT HANGERS

A. See Specification 233100 Sheet Metal.

2.05 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Structural Steel: ASTM A 36M, steel plates, shapes, and bars, black and galvanized.

C. Grout: ASTM C 1107, Grade B, factory-mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

1. Characteristics: Post hardening and volume adjusting recommended for both interior and exterior applications.

2. Properties: Nonstaining, noncorrosive and nongaseous

3. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 – EXECUTION

3.01 PREPARATION

A. All hangers, rod and supports shall receive two (2) coats of rust inhibitive paint.

B. Provide inserts for placement in concrete formwork.

C. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

D. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

E. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.02 INSTALLATION

A. Pipe Hangers and Supports.

1. Install in accordance with ASME B31.9, ASTM F 708, or MSS SP-89 or NFPA-13.

2. Support piping, ductwork and equipment as specified under Part 2.

3. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.

4. Place hangers with 24 inches of each horizontal elbow and on each side of valves 3” in size and up.

5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.

7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

8. Provide copper plated hangers and supports for copper piping or between hanger support and piping.

9. Prime coat (2 coats rust inhibitive paint) exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

10. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

B. Where pipe support members are welded to structural building framing, scrape, brush clean and apply two coats of zinc rich primer to welds.

3.03 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inch or ducts over 60 inches wide.

C. Finish inserts, flush with slab surface.

D. Inserts: Steel, slotted type, factory-painted.

1. Single rod: Similar to Grinnell Figure 281.

2. Multi-rod: Similar to Carpenter and Paterson 1480 Type 1.

3. Clip form nails flush with inserts.

4. Maximum load 75 percent of rating.

3.04 SUPPORTS FROM BUILDING CONSTRUCTION

A. Inserts, Beam Clamps, Steel Fishplates (in concrete fill only), Cantilever Brackets or Other Means.

B. Submit for Review.

C. Grouped Lines and Services

1. Trapeze Hangers fabricated of Bolted Angles or Channels.

D. Where Building Construction is Inadequate

1. Provide Additional Framing.

2. Submit for Review.

3.05 EXPANSION DEVICES

A. Expansion anchors: Similar to Hilti "Drop-In Anchor HDI" flush type.

B. Drill concrete to receive required expansion cases on concrete fasteners.

C. Install in shear only, not in tension.

3.06 EQUIPMENT BASES AND SUPPORTS

A. Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment.

B. Refer to Specification Section 15001 for additional information.

C. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

D. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.07 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base-metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.08 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.09 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230553 – MECHANICAL IDENTIFICATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install nameplates, valve tags, valve charts, stencils and pipe markers on all Mechanical equipment, piping and ductwork.

B. Provide nameplates with the unit number and service designation on all mechanical equipment.

C. Indicate all valve tag numbers on Record Drawings and submit framed under glass valve tag charts including valve service and location.

D. Install color coded ceiling tacks in acoustical tile ceilings or color coded tape on ceiling grid to identify location of equipment, valves and dampers that require regular maintenance or are part of a life safety system (fire dampers, smoke dampers, sprinkler valves or main isolation valves).

E. Provide underground plastic pipe markers 6 to 8 inches below finish grade, directly above buried pipes.

F. Provide manufactured pipe and ductwork identification stencils with flow arrows and service indicated. All backgrounds of the stencils shall be color coded with specific service designation

G. Prepare valve charts and frame under glass. All valves and the tag numbers shall be shown on the Record As-Built Drawings.

H. Provide valve computer data base to match chart.

I. Prepare and install exterior protected brass plaques indicating underground service entrances.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASME A 13.1 – Scheme for Identification of Piping Systems; The American Society of Mechanical Engineers.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for Additional Requirements.

C. Product Data: Submit product description including materials, attachment methods, color coding and lettering sizes.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. All materials, lettering and individual system color coding schemes shall be uniform and of one single manufacturer.

C. No identification shall be installed until all systems are complete and insulated.

D. All surfaces shall be cleaned.

E. No nametag or identification shall break or penetrate a surface used as a vapor barrier.

1.08 REGULATORY REQUIREMENTS

A. Conform to all local/state and NFPA requirements for color-coding or painting of systems, piping or equipment related to Life Safety or Fire Protection.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. All identification systems shall be stored in sealed containers in suitable locations to keep the containers and contents dry and clean.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.11 ENVIRONMENTAL REQUIREMENTS

A. All surfaces shall be cleaned and dry before applying any form of identification or tagging.

B. Consult with the manufacturer prior to installation for the proper tagging and identification procedure and materials to be used on exterior outdoor equipment.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. Acceptable manufactures contingent on compliance with the specification.
   1. W. H. Bradey Company or approved equal.

2.03 PIPE IDENTIFICATION AND VALVE TAGS

A. All piping, except that piping which is within inaccessible chases, shall be identified with semi-rigid plastic identification markers equal to Seton Setmark pipe markers.

1. Direction of flow arrows is to be included on each marker.

2. Each marker background shall be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the "Scheme for the Identification of Piping Systems" (ASME A13.1-1981).

3. Setmark snap-around markers shall be used for overall diameters up to 6" and strap-around markers shall be used above 6" overall diameters.

4. Markers shall be located:

a. Adjacent to each valve
b. At each branch
c. At each cap for future
d. At each riser takeoff,
e. At each pipe passage through wall (each side)
f. At each pipe passage at 20' – 0" intervals maximum.

5. Under ground pipe markers:

a. Provide detectable tape on all underground piping:
b. Labels shall be color coded and labeled the same as indoors.

B. Valve tags

1. All valves shall be designated by distinguishing numbers and letters carefully coordinated with a valve chart.

2. Valve tags shall be color coded 0.032" anodized aluminum tags, with engraved letters similar to Seton S Type 250-BL or approved equal.

a. HVAC tags shall be round 2" diameter, similar to Seton 15426.

b. Plumbing tags shall be square 2" x 2" similar to Seton 42769.

c. Fire Protection tags shall be square 2" x 2" similar to Seton 42769 RED.

d. Lettering shall be ¼" high for type service and ½" for valve number. Tag shall indicate service and valve number.

e. Each service shall be a different color.

3. Tag shall be attached to valves with chain similar to Seton No 16 stainless steel jack chain.

4. Whenever a valve is above a hung ceiling, the valve tag shall be located immediately above the hung ceiling.

C. Furnish a minimum of two (2) typed valve lists

1. Each framed under glass or Plexiglas. Each chart shall be enclosed in an approved 0.015" thick plastic closure for permanent protection.

2. Valve numbers shall correspond to those indicated on the Record Drawings and on the printed valve lists.

3. The printed list shall include the valve number, location and purpose of each valve.

4. It shall state other necessary information such as the required opening or closing of another valve when one valve is to be opened or closed.

5. Printed framed valve lists shall be displayed in each Mechanical Room or in a location designated by the Owner.

D. Valve data base.

1. Provide a valve data base for all valves to operate on the building computer.

2. Every valve shall include:

a. Tag Number

b. Service

c. Size

d. Operation

e. Location

f. Manufacture

g. Model number

h. Submittal reference

2.04 DUCTWORK IDENTIFICATION

A. All ductwork (supply, return, exhaust, etc.) serving multiple spaces or floors shall be identified with directional flow arrows and unit identification numbers (AHU-1, EX-1, etc.) on the side of each duct (or bottom if abutting other systems or obstructions).

B. All flow arrows and labels shall be similar to Seton Name Plate Company vinyl labels or stencil painted.

C. The kitchen hood exhaust system shall also have identified access doors with numbers of specific doors identified on the Record As-Built Drawings.

D. All duct access doors.

2.05 EQUIPMENT NAMEPLATES

A. Equipment nameplates shall be 3" x 6" long, 0.02" aluminum with a black enamel background with engraved natural aluminum letters similar to Seton Style 2065-20. Nameplate shall have pressure sensitive taped backing.

B. The nameplate shall contain the unit or equipment designation ("AHU" for air handling unit, "HP" for heat pump, "P" for circulating pump, etc.), unit number and area or system served.

C. Nameplates for exterior equipment shall be applied with waterproof adhesive.

2.06 UTILITY ENTRANCE DESIGNATIONS

A. Provide a brass wall plaque, minimum 0.020" thickness, secured to the exterior wall just above the grade line for all buried service entrances or exits. Samples are: Water Service Below; Gas Service Below; Sanitary Sewer Below; Storm Sewer Below; Irrigation Water Below; etc.

2.07 CEILING TACKS OR TAPE

A. Provide steel color coded ¾ inch diameter ceiling tacks in acoustical tile ceilings or color coded tape applied to ceiling grid to locate equipment, valves or dampers that require regular maintenance or are part of a Life Safety System.

B. The tacks or tapes shall be color codes as follows (coordinate with Owner):

1. Yellow – HVAC

2. Red – Life Safety (fire dampers, etc.)

3. Green - Plumbing Valves.

4. Blue – Heating/Cooling Valves.

PART 3 – EXECUTION

3.01 PREPARATION

A. All surfaces shall be cleaned and insulated (if applicable) prior to installing any identification.

B. Exterior surfaces of outdoor equipment shall be dry and prepared to accept the specified identification.

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion. Seal with clear lacquer.

B. Install valve tags with chain.

C. Install duct markers in accordance with manufacturer's instructions.

D. Install plastic pipe markers in accordance with manufacturer's Instructions.

E. Install plastic tape markers complete around pipe in accordance with manufacturer's instructions.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, boilers, domestic hot water heaters, fire pumps, heat transfer equipment tanks, water treatment devices, etc. with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Install detector tape on all under ground services in accordance with the manufactures recommendations.

J. Identify thermostats relating to air handling equipment serving multiple spaces.

K. Identify valves in main and branch piping with valve tags.

L. Tag automatic controls, instruments and relays. Key to control schematic.

M. Identify piping, concealed or exposed, with pipe markers or where buried using plastic tape pipe markers. Use tags on piping ¾ inch diameter and smaller. Identify service, flow direction and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

N. Identify ductwork with plastic nameplates and flow arrows. Identify with air handling unit or fan identification number and area served. Locate identification at air handling unit or fan, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION 230553

SECTION 230584 – THROUGH-PENETRATION FIRESTOP SYSTEMS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:

1. Floors

2. Roofs

3. Walls and partitions

4. Smoke barriers

5. Construction enclosing compartmentalized areas.

6. Other rated assemblies.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. American Society for Testing and Materials Standards (ASTM):

1. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials

2. ASTM E814: Standard Test Methods for Fire Tests of Through-Penetration Firestops

3. ASTM E119: Standard Test Methods for Fire Tests of Building Construction Materials

4. ASTM E1399: Standard Test Methods for Cyclic Movement and Measuring of Joint Systems

5. ASTM E1725: Standard Test Methods for Fire Tests of Fire-Resistive Barrier Systems of Electrical Systems Components

6. ASTM E1966: Standard Test Methods for Fire Tests of Joints

B. Underwriters Laboratories, Inc. (UL):

1. UL 723 Surface Burning Characteristics of Building Materials

2. UL 1479 Fire Tests of Through-Penetration Firestops, including optional air leak test

3. UL 2079 Fire Test of Building Joint Firestop systems

4. UL Fire Resistance Directory (Component Listing Test Criterion)

C. National Fire Protection Agency (NFPA)

1. NFPA 80 Standard Fire Door and Window Assembly Tolerances

2. NFPA 252 Standard Fire Test for Fire Rated Doors (not specified for positive or negative furnace test pressure)

3. NFPA 257 Standard Fire Test for Fire Rated Windows (not specified for positive or negative furnace test pressure)

4. NFPA 101 Life Safety Code

5. NEC 70 National Electrical Code

1.05 PERFORMANCE REQUIREMENTS

A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to

requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.

1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.

2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.

3. Fire-resistance-rated floor assemblies.

4. Fire-resistance-rated roof assemblies.

B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas.

1. Penetrations located outside wall cavities.

2. Penetrations located outside fire-resistive shaft enclosures.

3. Penetrations located in construction containing fire-protection rated openings.

4. Penetrating items larger than 4-inch diameter normal pipe or 16 sq. in. in overall cross-sectional area.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide product that after curing do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.

2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.

3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

E. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-development ratings of less than 450, as determined per ASTM E 84.

1.06 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. See Section 230500 for Additional Requirements.

D. Product Data: For each type through-penetration firestop system product indicated.

E. Shop Drawings: For each through-penetration firestop system show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating items. Include firestop design designation of testing and inspecting agency acceptable to authorities having, jurisdiction that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.

2. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer.

F. Submit complete plans indicating clearly where all seals are located and the type of seal to be used at that location

G. Qualification Data: For firms and persons specified to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

H. Product Certificates: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

I. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.07 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.08 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:

1. Through-Penetration Firestop Systems tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, ITS, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.

2. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:

a. Through-penetration firestop system products hear classification marking of qualified testing and inspecting agency.

b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:

1) UL in "Fire Resistance Directory."

2) ITS in "Directory of Listed Products."

1.09 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable, qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.

C. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration fires top systems when ambient or substrate temperatures are outside limits permitted by through penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.12 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Owner's inspecting agency at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until Owner's inspecting agency and building

inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 MANUFACTURERS

A. Acceptable manufacturers subject to compliance with the specifications shall be one of following:

1. United States Gypsum Company or approved equal.

2.03 FIRESTOPPING GENERAL

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and fired experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:

a. Slag-/rock-wool-fire insulation.

b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.

c. Fire-rated form board

2. Temporary forming materials

3. Substrate primers

4. Collars

5. Steel sleeves

2.04 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop systems manufacturer and the following requirements:

1. Remove from surfaces of openings substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products

and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contactor by cleaning methods used to remove smears from firestop systems materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD-QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified independent inspecting agency to inspect through-penetration firestop systems and to prepare test reports.

1. Inspecting agency will state in each report whether inspected through-penetration firestop systems comply with or deviate from requirements.

B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued.

C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.05 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels.

1. The words: "Warning-Through-Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Through-penetration firestop systems designation of applicable testing and inspecting agency.
4. Date of installation.
5. Through-penetration firestop systems manufacturer's name.
6. Installer's name.

3.06 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END OF SECTION 230584

SECTION 230593 – TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Provide all labor, instruments and materials necessary to completely test, adjust and balance all HVAC systems and equipment installed under this contract.

B. All instruments shall be newly calibrated for this specific project.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. AABC MN-1 – National Standard for Testing and Balancing Heating, Ventilating and Air Conditioning Systems.

2. ASHRAE 111 – Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

1.05 SYSTEM DESCRIPTION

A. Provide under this contract the services of an independent test and balance firm that specializes in testing and balancing of HVAC systems. The following services shall be provided:

1. Balance Plan Check and Review: Review the design documents prior to commencing balancing. Submit any noted questions or discrepancies in writing to the Architect.

2. On-going job site inspections of equipment, controls and metering devices during construction to verify conformance with design specifications, manufacturer's installation instructions.

3. Air System Balance

4. Hydronic System Balance

5. Control Systems Verification

6. Special System Testing and Verification

a. Duct leakage testing

b. Sound and vibration testing

7. System Performance Verification

8. Opposite Season Test

1.06 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for Additional Requirements.

C. Submit name of testing, adjusting and balancing contractor for approval within 30 days after award of Contract.

D. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting and balancing of systems and equipment to achieve specified performance.

1. Submit under provisions of Section 01400 – Quality Control.

2. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing and equipment data required.

3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for inclusion in operating and maintenance manuals.

4. Provide reports in letter size, 3 ring binder manual, complete with index page and indexing tabs with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.

5. Include detailed procedures, agenda, sample reports forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.

6. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE 111, NEBB forms, or forms containing information indicated in Schedules.

7. Include the following on the title page of each report.

   a. Name of Testing, Adjusting and Balancing Agency.

   b. Address of Testing, Adjusting and Balancing Agency.

   c. Telephone number of Testing, Adjusting and Balancing Agency.

   d. Project name.

   e. Project location.

   f. Project Architect.

   g. Project Engineer.

   h. Project Contractor.

   i. Report date.

E. Project Record Documents: Record actual locations of all water systems balancing valves and rough setting.

1.07 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.08 DEFINITIONS

A. AABC: The Associated Air Balance Council is a non-profit association of independent, certified agencies specializing in testing and balancing HVAC systems.

B. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.

C. HVAC: Heating, Ventilating and Air Conditioning.

D. TAB: Testing, Adjusting and Balancing of HVAC Systems to meet design objectives and obtain optimum system performance.

E. TABB: Testing, Adjusting, and Balancing Bureau

F. NEBB: National Environmental Balancing Bureau

G. TBE: Test and Balance Engineer is an individual certified by AABC as having a degree in Engineering and (3) years of test and balance experience, or (5) years of background in the air conditioning field and (5) years continuous field experience in testing and balancing work. The TBE must also pass the AABC Test and Balance Engineer Certification Examination.

1.09 AGENCY QUALIFICATIONS

A. Testing and balancing agency shall be a member of AABC or NEBB or TABB with a minimum of five (5) years of documented experience.

B. An AABC, NEBB, TABB certified testing and balancing person shall be responsible for certification of the total work of this section.

C. All work shall be performed in accordance with AABC National Standards. If these specifications set forth more stringent requirements than the AABC National Standards, the more stringent specifications shall prevail.

1.10 QUALIFICATION SUBMITTALS

A. Testing and Balancing Agency shall submit a company resume listing personnel and project experience in the field of air and hydronic system balancing.

B. Testing and balancing agency shall submit an inventory and calibration data of all instruments and devices in possession of the balancing agency to enable the

Owner or his representative to evaluate the balancing agency's performance capability.

C. The testing and balancing agency shall submit to the Owner or the Owner's representative, upon acceptance of the contract, an AABC or NEBB or TABB "Quality Assurance Guaranty."

D. Within (30) days after acceptance of the contract, the testing and balancing agency shall submit to the Design Engineer a working agenda which will include procedures for testing and balancing each type of air and water flow system. The Test and Balance Report format will also be submitted indicating data to be recorded.

1.11 CONTRACT DOCUMENTS

A. Within (30) days after selection of the test and balance agency, the Mechanical Contractor shall provide the agency with the following:

1. Construction Drawings

2. Equipment Specifications

3. Equipment Submittals

B. The testing and balancing agency shall be provided the following as issued or received:

1. Change Orders/Current Updated Construction Mechanical Drawings incorporating all revisions

2. Equipment Manufacturer's Submittal Data

3. Mechanical/Air Conditioning Contractor's Shop Drawings

4. Temperature Control Drawings

5. Project Schedule

1.12 NOTIFICATION AND SCHEDULING

A. A prebalance conference shall be held prior to job start as scheduled by the Owner or Owner's representative. Attendees at the meeting shall include representatives of the test and balance agency, General Contractor, Mechanical Contractor, Control Contractor, Owner and Mechanical Engineer.

B. The schedule for testing and balancing the HVAC system shall be established by the Owner or Owner's representative, in coordination with the testing and balancing agency on a critical path network.

C. The testing and balancing agency is responsible for initiating this continuing coordination to determine schedule for final testing and balancing services.

D. It will be necessary for the testing and balancing agency to perform its services in close coordination with the Mechanical Contractor, with all scheduling and deficiencies reported through the Owner or Owner's representative.

E. Before testing and balancing commences, the testing and balancing agency shall receive notification, in writing, from the Mechanical Contractor that the system is operational, complete, and ready for balancing.

F. A completed system exceeds physical installation: the Mechanical Contractor shall certify that all prime movers, fans, pumps, cooling towers, boilers, etc., are installed in good working order, and that full load performance has been preliminary tested.

G. The Mechanical Contractor shall certify in writing, that all equipment has been checked, started, adjusted by the manufacturer, and operated for the specified period of time.

1.13 COORDINATION WITH OTHER TRADES

A. To bring the HVAC system into a state of readiness for testing, adjusting and balancing, the Mechanical Contractor shall perform the following:

1. Air Distribution Systems

a. Ensure that all splitters, extractors, volume, smoke and fire dampers are properly located and functional. Dampers serving requirements of smoke, minimum and maximum outside, return, relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.

b. Verify that all exhausts are installed and operational.

c. Ensure that all fans are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating.

d. Make any necessary changes to the sheaves, belts, and dampers, as required by the testing and balancing agency, at no additional cost to Owner.

e. Install clean filters prior to testing.

2. Water Circulating Systems

a. Check all pumps to verify pump alignment and rotation.

b. Ensure that systems are clean, with the proper strainer screens installed for normal operation.

c. Check all pump motors for current and voltage, to ensure that motors do not exceed nameplate rating.

d. Provide overload protection of proper size and rating.

e. Ensure that all water circulating systems shall be clean, full and free of air, that expansion tanks are set for proper water level, and that all air vents are installed at high points of systems and are operating.

f. Check and set operating temperature of heat exchangers to design requirements.

B. The Temperature Control Contractor shall perform the following:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, and fire and freeze stats.

2. Verify that all controlling instruments are calibrated and set for design operating conditions.

3. Calibrate room thermostats after installation and before the thermostat control verification tests are performed. The test and balance agency shall verify the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.

4. The Control Contractor shall allow sufficient time in the project to provide assistance and instruction to the testing and balancing agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers or any other device that may need

setpoints changed so that the testing and balancing work can be performed.

C. The Mechanical Contractor, Temperature Control Contractor, and the suppliers of the HVAC equipment shall all cooperate with the testing and balancing agency to provide all necessary data on the design and proper application of the system components. In addition, they shall furnish all labor and materials required to eliminate any system deficiencies.

D. In coordination with the General Contractor, the testing and balancing agency shall arrange for an area of ample size and convenient location for storage of tools, equipment, and other items as required.

1.14 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.16 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.01 BUY AMERICA POLICY

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. The Owner, General Contractor or HVAC Contractor shall procure the services of an independent Balancing and Testing Contractor who specializes in the balancing and testing of heating, ventilating and air conditioning systems to balance and adjust, all moving equipment and air distribution and exhaust systems and test all water systems and equipment, as herein specified. All work by the Balancing Contractor shall be done under direct supervision of a qualified heating and ventilating Engineer employed by the Balancing Contractor. Balancing Contractor shall submit credentials and be approved prior to any contract award.

B. Balance and testing shall not begin until all HVAC systems have been completed and are in full working order, as determined by the Architect. Where construction is phased, the Testing and Balancing Contractor shall submit a plan of action which outlines how each phase will be balanced and how, when completed, the entire system will be verified to be tested and balanced. The Balancing Contractor shall coordinate his work with the HVAC and ATC Contractors, shall place all heating, ventilating and air conditioning systems and equipment into full operation, and continue the operation of same during each working day of adjusting and balancing.

C. The Balancing Contractor shall perform all tests as hereinafter specified, compile the test data, and submit five (5) copies of the complete test data to the Owner, General Contractor or HVAC Contractor for forwarding to the Architect for evaluation and approval.

D. The Owner, General Contractor and HVAC Contractor shall award the test and balance contract to the approved agency at the beginning of construction of the project to allow the Balancing Contractor to schedule this work in cooperation with the HVAC Contractor, ATC Contractor and other Trades involved and comply with completion data and requirements, as well as provide a list of areas where special requirements for balancing devices (dampers, valves) might occur.

E. The Balancing Contractor shall provide all testing instruments used for balancing air and water systems. Testing instruments shall have been calibrated within a period of six (6) months prior to balancing. Types, serial numbers and dates of calibration of all instruments shall be listed in the final air and water balance reports herein specified.

F. The Architect's, Engineer's and Owner's designated representatives shall be notified minimum five (5) days in advance of proceeding with balancing work to allow time for the witnessing of the testing, balancing and adjusting.

G. The Balancing Contractor shall provide all manpower, instruments, temporary connections and all other materials required to accomplish the balancing and testing as hereinafter specified. In the case of phased construction, the action plan shall include an explanation of all temporary facilities and their effect on the overall system.

H. The Balancing Contractor shall balance cooling systems in the air conditioning season and heating systems in the heating season. **This requirement is mandatory.**

I. In the event it becomes necessary for the Owner to balance the HVAC systems correctly, after the balancing is complete, the cost of this work will be back charged to the Balancing Contractor.

2.03 SCHEMATIC SYSTEM DRAWINGS

A. Piping Systems

1. The Balancing Contractor shall prepare schematic diagrammatic drawings for the following systems:

a. Hot Water

2. The drawings will be 1-line schematic representation of the systems as they are installed, indicating all major automatic control valves, strainers, pressure reducing valves, etc., as well as all water flow and energy meters.

3. The diagrams shall indicate, in addition to the graphic representation requirements outlined above, all pressure drops (design conditions and actual conditions) of each valve, strainer, meter, etc., as well as all flows at each meter.

4. The use of the Engineer's construction drawing diagrams can be utilized by the Balancing Contractor as the base of the diagrams required. However, the drawings will have to be updated by the Balancing Contractor for field modifications which may have occurred during construction.

B. Ductwork Systems

1. The Balancing Contractor shall prepare schematic diagrammatic drawings for the following:

a. All exhaust air systems

2. The drawings will be 1-line airflow schematics emanating from the air handling equipment, through shafts, to the first major split of duct branches on each floor. The drawings will indicate the air quantities measured at these major branches, pressure drop and any other pertinent information deemed necessary by the Architect.

C. The intent of the required documentation would be to clearly indicate the balancing and performance of the systems as they are installed. Furthermore, the above-required information will be utilized by the Owner for future renovation and/or alterations of the various systems. Therefore, the drawing content and presentation will be submitted to the Architect for review prior to actual commencement of the work. In the case of phased construction, the schematics shall indicate the limit of each phase and any temporary measures taken to obtain system performance.

D. The drawings shall be produced on MicroStation latest, and a disc and one (1) set of reproducible vellums shall be submitted to the Owner through the Architect, for his use. All costs associated with the production of the documents shall be included under the Balancing Contractor's contract.

E. Test Code Drawings

1. Each report shall contain a single line drawing or drawings of the air distribution system with the fan system, applicable zoning, etc., indicated. Each and every outlet supply and return shall be indicated on this drawing by a number corresponding to the number of the outlet test sheet.

2.04 TEST FORMS USED BY BALANCING ENGINEERS AND TECHNICIANS SHALL BE SET UP TO INCLUDE THE FOLLOWING INFORMATION:

A. Each sheet shall have the job name and address, the name of the Balancing Contractor, Owner, Architect and Engineer, the instruments used to perform the test, and the name of the test Technician, date and time of test, outside db/wb temperatures.

B. All forms shall be submitted on a standard 8 1/2" by 11" good quality paper, bound together to form a complete report. All forms shall be submitted in typewritten form; handwritten forms are not acceptable. Cover of first sheet shall list the name of the job and the location of same. Copies of all forms shall be submitted to the Architect for review and acceptance prior to the work beginning.

C. Exhaust and Ventilating Fan Test Sheets

1. Each sheet shall contain in two (2) columns, one (1) for specified conditions and one (1) for test conditions obtained. Variable volume systems data is to be submitted for both maximum and minimum air flows.

2. All final sheets shall list the following data:

a. Exhaust fan system and exhaust fan number.

b. Fan manufacturer.

c. Fan curve.

d. Size and model.

e. Motor HP, voltage and phase.

f. Changes made or recommended.

g. Amperage nameplate rating.

h. Final operating amperage.

i. Fan RPM.

j. Total CFM.

k. Suction static, discharge static, total static.

D. Pump Test Sheets

1. For each pump the following data shall be listed:

a. Pump number and system name.

b. Pump manufacturer and model number.

c. Pump curve.

d. Motor HP and RPM.

e. Voltage - Nameplate, test.

f. Amperage - Nameplate, test.

g. GPM, rated, tested.

h. Pressure rise rated, test.

i. Inlet pressure, outlet pressure.

j. Inlet temperature.

k. Shut-off pressure.

E. Calibration of air flow measurement stations in cooperation and in conjunction with ATC contractor, provide all necessary pitot tube traverses and/or other air measurements necessary to field verify the accuracy of all installed air flow measurement stations at all air handling units, exhaust air handling units, return fans and cuts. Calibration reading s shall be taken at 100%, 75%, 50% of rated flow and a curve shall be prepared that indicates any deviation between air flow station readings and field readings at these floors.

PART 3 - EXECUTION

3.01 AIR SYSTEM BALANCING AND TESTING PROCEDURES

A. The Balancing Contractor shall perform the following tests, and balance all systems in accordance with the following requirements:

1. Test and adjust blower RPM or blade pitch angle on vane axial fans to achieve design requirements.

a. Test and record motor full load ampere.

b. Make pitot tube transverse of main supply, return and exhaust air ducts to obtain design CFM at fans.

c. Test and report system static pressure, suction and discharge.

d. Test and adjust system for design CFM recirculated air.

e. Adjust all main exhaust air ducts to proper design CFM.

f. Test and adjust each grille to within ±5% of design requirements.

g. Measure air quantities in main and branch ducts by traversing entire cross sectional area of duct with pitot tube. Ducts having velocities of 1000 feet per minute or more shall be measured with inclined manometers (draft gauge) or magnehelic gauges; ducts having velocities of less than 1000 per feet per minute shall be measured with micromanometers, hook gauges, or similar low pressure instruments. Openings in ducts for pitot tube insertion shall be sealed with snap-in plugs and covered with duct tape after air balance is complete. Diffuser, grille and register air quantities shall be determined by direct reading velocity meters in accordance with the manufacturer's recommendations.

h. Identify, adjust, balance and measure air quantities in all types of exhaust "trunks", where applicable. Identify systems by fan designation and room name.

i. Obtain design air quantities in main ducts by adjusting fans. Branch duct air quantities shall be adjusted by volume dampers. Dampers shall be permanently marked after air balance is complete to enable them to be restored to their correct position if disturbed at any time.

j. As part of this Contract, the Balancing Contractor shall change the pulleys, belts, and fixed sheaves to provide for permanent sheaves,

pulleys and belts, based on the final balancing, in order to ensure proper air delivery of the various systems. The Balancing Contractor shall also make all necessary adjustments to vane axial fan blade pitch angle to achieve required airflow.

k. In cooperation with the ATC Contractor, determine the proper setpoint for all automatically operated dampers, air valves, static pressure sensors, other variable or controllable devices requiring coordination between Balancing Contractor and ATC Contractor. The Balancing Contractor shall determine the lowest system static setpoint possible that will deliver the proper air quantities to all outlets at the maximum cooling condition, and will adjust the fan system to operate at its most economical setting to achieve this static setpoint. Fans will be adjusted to the most economical setting by adjusting the fan speed (or blade pitch angle) with any variable volume devices in their maximum or wide-open position. Final static pressure setpoints are to be recorded in the test and balance report and listed for each unit.

l. Any dampers, safing of baffles required for final balancing, as determined by the Balancing Contractor the Architect, will be provided by the HVAC Contractor and Sheet Metal Contractor to ensure proper performance, at no extra cost to the Owner.

3.02 WATER SYSTEM BALANCING AND TESTING PROCEDURES

A. Preparation of the System for Water Testing and Balancing

1. The Balancing Engineer or Technician must prepare the water system for balancing in the following manner:

a. Open all valves to full position, including zone stop valves, return line balancing cocks and close all bypass valves, including system differential pressure bypass valve if applicable.

b. Remove, clean and/or replace all strainers.

c. Examine water in system to determine if it has been treated and is clean.

d. Check pump rotation, correct if necessary.

e. Check expansion tank to make sure it is not air bound and that the system is full of water.

f. Check all air vents at high points of water systems to make sure they are installed properly and are operating freely.

g. Make certain all air is removed from circulating system.

h. Check operation of differential automatic bypass valves, set valve in closed position.

i. Check and set operating temperature of systems to design requirements.

j. Complete air balancing must have been accomplished before water balance is begun.

k. Set all temperature controls so that all heating zones are calling for full heating.

l. Set hot water systems to proper GPM delivery.

m. Check leaving water temperature, return water temperature and pressure drop through all zones. Reset to correct design temperatures.

n. Balance all heating elements.

o. After making adjustments to zones and other waterflow elements, reset settings at pumps, as required to obtain proper flows.

p. Determine system operating differential pressure and, in conjunction with the ATC Contractor, set any differential pressure valves for proper operation.

q. Upon completion of flow readings and zone adjustments, and after water balance is complete, permanently mark all balancing valves, cocks and flow meters so that they can be restored to their correct position if disturbed. Properly set memory stops on all balancing valves so equipped.

r. After the Balancing Contractor sets all waterflow balancing devices to proper design GPM, he shall mark the GPM flows on the piping schematic drawings.

s. The Balancing Contractor shall determine the lowest possible differential pressure control point possible for all variable speed pumping systems and for all differential pressure bypass control valves. In systems that have both variable speed pumping

controlled by differential pressure and a differential pressure bypass valve, the Balancing Contractor shall assure, in conjunction with the ATC Contractor, that a minimum of 3 psig difference in setpoints is maintained between the two control settings with the differential pressure setpoint for the variable speed pumping system being the lower of the two settings.

3.03 INSTALLED ELEMENT TEST PROCEDURES

A. Element identification (location or number designation).

B. Required temperature drop corrected for actual entering air and water conditions.

C. Element adjusted until the required drop is obtained.

3.04 CONTROL SYSTEMS VERIFICATION

A. Verify all control devices are properly connected.

B. Verify all dampers, valves and other controlled devices are operated by the intended controller.

C. Verify all dampers and valves are in the position indicated by the controller (open, closed, modulating).

D. Verify the integrity of valves and dampers in terms of tightness of close off and full open positions.

E. Check all valves are properly installed in the piping system in relation to direction of flow and location.

F. Check calibration of all controllers.

G. Verify the proper application of all normally open and normally closed valves.

H. Check the location of all thermostats and humidstats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.

I. Check the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the testing and balancing agency.

J. Check the sequence of operation that any control mode is in accordance with approved shop drawings. Verify that only minimum simultaneous heating and cooling occurs. Observe that the control valves at the boiler/heat pump loop are properly sequenced.

K. Verify all controller setpoints meet the design intent.

L. Check all dampers for free travel.

M. Verify the operation of all interlock systems.

N. Perform all systems verification to ensure the safety of the system and its components.

3.05 SYSTEM PERFORMANCE VERIFICATION

A. At the time of final inspection, the test and balance agency shall recheck, in the presence of the Owner's representative, specific and random selections of data, air quantities, and air motion recorded in the Certified Report.

B. Points and areas for recheck shall be selected by the Owner's representative.

C. Measurement and test procedures shall be the same as approved for work forming basis of Certified Report.

D. Selections for recheck, specific plus random, will not normally exceed 25% of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

E. If random tests elicit a measured flow deviation of 10% or more from that recorded in the Certified Report listings, by 10% or more of the selected recheck stations, the report is rejected, all systems shall be readjusted and tested, new data recorded, new Certified Report submitted, and new inspection tests made, all at no additional cost to Owner.

F. Following system verification of the Certified Report by the Owner's representative, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the testing and balancing agency so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after system verification.

3.06 OPPOSITE SEASON TEST

A. The testing and balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The testing and balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

3.07 RECORD AND REPORT DATA

A. The test and balance report shall be complete with logs, data and records as required herein. All logs, data and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the testing and balancing agency's certified balancing engineer.

B. Six (6) copies of the test and balance report are required and shall be submitted to the Owner or the Owner's representative.

C. The report shall contain the following general data in a format selected by the testing and balancing agency.

1. Project number.

2. Contract number.

3. Project title.

4. Project location.

5. Project Architect.

6. Project Mechanical Engineer.

7. Test and Balance Agency.

8. Balancing Engineer.

9. General Contractor.

10. Mechanical Contractor.

11. Date tests were performed.

12. Certification.

D. The test and balance report shall be recorded on report forms conforming to the recommended forms in AABC National Standards. At a minimum, the report shall include:

1. Preface: A general discussion of the system, any abnormalities and problems encountered.

2. Instrumentation List: The list of instruments including type, model, manufacturer, serial number, and calibration dates.

3. System Identification: In each report the supply, return and exhaust openings and traverse points shall be numbered and/or lettered to correspond to the numbers and letters used on the report data sheets.

4. Air Handling Equipment (Fans, etc.)

    a. Manufacturer, model number, and serial number.

    b. All design and manufacturer related data.

    c. Total actual CFM by traverse if practical; if not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.

    d. Suction and discharge static pressure of each fan, as applicable.

    e. Total CFM.

    f. Actual operating current, voltage, and brake horsepower of each fan motor.

    g. Final RPM of each fan.

    h. Fan and motor sheave manufacturer, model, size, number of grooves, and center distance.

    i. Belt size and quantity.

    j. Static pressure controls final operating setpoints.

5. Pumps

    a. Manufacturer, size, and serial number.

    b. All design and manufacturer's related data.

    c. Pump operating suction and discharge pressure and final total dynamic head.

    d. No flow (pump discharge valve closed) suction and discharge pressure and corresponding total dynamic head. This procedure is to determine actual impeller size.

    e. Rated and actual operating current, voltage, and brake horsepower of each pump motor.

f. Submit pump curve showing design, operating, and no-flow points of operation.

6. Boilers

a. Manufacturer, model number, and serial number.

b. All design and manufacturer's rated data.

c. Rated and actual pressure drop across boilers and related GPM.

d. Entering and leaving water temperatures.

7. Electric Heating/Gas Heating

a. Manufacturer and model number.

b. All design and manufacturer rated data.

c. Actual operating current and voltage.

d. Zone location and identification number.

END OF SECTION 230593

SECTION 230598 – MECHANICAL VIBRATION CONTROLS & SEISMIC RESTRAINTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all necessary vibration isolation materials to eliminate excessive noise and vibration from all building mechanical systems.

B. Seismic restraints for all systems shall be installed in accordance with:

C. Code IBC 2003

D. Use group II

E. Seismic design category C

F. Site classification E

G. Building Ip (Importance Factor) 1 or 1.5

1. All Life safety systems Importance Factor = 1.5
2. Emergency electrical Importance Factor = 1.5

3. Hazardous systems Importance Factor = 1.5

   a. Oil piping Importance Factor = 1.5
   b. Gas piping Importance Factor = 1.5
   c. Gas Vents Importance Factor = 1.5

4. HVAC
    a. All stair pressurization systems Importance Factor = 1.5
    b. Snow melting piping system Importance Factor = 1.0

5. Plumbing systems
    a. Domestic water system Importance Factor = 1.5
    b. Non Potable water system Importance Factor = 1.0
    c. Storm Drain system Importance Factor = 1.0

6. Other systems

    a. All other ductwork systems Importance Factor = 1.5
    b. All other piping systems Importance Factor = 1.5
    c. All other electrical systems Importance Factor = 1.5
    d. All other plumbing systems Importance Factor = 1.5
    e. Control conduits Importance Factor = 1.5

H. Piping types

1. High deformability piping:

    a. Welded steel
    b. Welded stainless steel
    c. Socket welded steel
    d. Grooved steel that is ASME B31.1
    e. Braised copper
    f. Grooved copper

2. Limited-deformability

    a. Threaded Steel
    b. Grooved steel that is not ASME B31.1
    c. Soldered copper

3. Low-deformability

    a. PVC
    b. Cast iron
    c. Glass
    d. Non-ductile plastic

I. All trapeze supported Items weighing 10 Lbs per foot or greater shall be braced. This weight shall include all pipes and conduits filled with water.

J. Secure all permits and local/state approval for the installation of all components included under this Section.

K. The work in this Section shall include the following:

1. Vibration isolation elements for equipment.
2. Equipment isolation bases.
3. Piping flexible connectors.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.
6. Seismic restraints for ductwork
7. Seismic restraints for piping
8. Certification of seismic restraint designs and installation supervision.
9. Certification of seismic attachment of housekeeping pads.

L. Coordinate closely with Hangers and Supports, Pipe Expansion and Structural documents.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Refer to Section 230516 – Pipe Expansion.

C. Refer to Section 230529 – Hangers and Supports.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NEBB– Procedural Standards for Measuring Sound and Vibration; National Environmental Balancing Bureau.
2. NEBB– Sound and Vibration in Environmental Systems; National Environmental Balancing Bureau.
3. SMACNA – Guidelines for Seismic Restraint of Mechanical Systems.
4. ASHRAE Guidelines – HVAC Applications; Chapter– Sound and Vibration Control, Chapter – Seismic Restraint Design, Latest Edition.
5. ASCE Standard 7 Minimum Design Loads for Buildings and Other Structures

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. The Vibration Isolation Submittal shall include descriptive data for all products and materials including the following:

1. Product Descriptions

a. A complete description of products to be supplied, including product data, dimensions, specifications and installation instructions.

b. An itemized list of isolated and non-isolated equipment. Detailed schedule and selection data for each vibration isolator and seismic restraint supporting equipment, including:

1) Equipment identification mark
2) Isolator type
3) Actual load
4) Static deflection expected under actual load
5) Specified minimum static deflection
6) Additional deflection-to-solid under load
7) Ratio of spring height under load to spring diameter
8) Base type
9) Seismic restraint type

c. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.

2. Show equipment base construction for all equipment, including dimensions, structural member sizes and support point locations.

3. Indicate isolation devices selected with complete dimensional and deflection data.

4. Show all methods of suspension and support for ceiling hung equipment.

5. Detail methods of isolation for ducts and pipes piercing walls and slabs.

6. Provide specific details of seismic restraints and anchors, including number, size and locations for each piece of equipment.

7. Provide special details necessary to convey complete understanding of the work to be performed.

D. Seismic Analysis and Certification submittals shall include the following:

1. Seismic restraint calculations must be provided for all connections of equipment to the structure.

2. Calculations to support seismic restraint designs shall be stamped by a registered Professional Engineer.

3. Analysis must indicate calculated dead loads, derived loads, and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and weld length.

4. A seismic design liability insurance certificate must accompany all submittals.

5. Coordinate all hangers and supports.

6. Provide Approved Agencies Certificate of Compliance meeting Seismic Category D for all components. Tests shall include anchorage, structural and on line capability from analytical or shaker test method.

a. Where the requirements of this specification cannot be met by any vendor, the contractor will submit a written summary indicating the lack of resources.

E. Submission of samples may be requested for each type of vibration isolation and seismic device. After approval, samples will be returned for installation at the job if requested. All costs associated with submission of samples shall be borne by the Contractor.

F. Provide seismic certifications for all equipment including, but not limited to:

1. Boiler
2. Fans
3. VFDs
4. Pumps
5. Seismic joints

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. All vibration isolators shall have calibration markings or some method to determine the actual deflection under the imposed load after installation and adjustment.

C. All isolators shall operate within the linear portion of their load versus deflection curves. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range of at least 50% above the design deflection.

D. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than ±10%, and shall be non-resonant with equipment forcing frequencies or support structure natural frequencies.

E. All neoprene components shall have a shore hardness of 30 to 50 ±5%, after minimum aging of (20) days or equal oven aging.

F. Substitution of internally isolated and restrained equipment in lieu of the isolation and restraints specified in this Section is acceptable provided all conditions of this Section are met. The equipment manufacturer shall provide a letter of guarantee stating that the specified noise and vibration levels will be obtained and that the seismic restraints shall be in compliance with these specifications. All costs for converting to the specified external vibration isolation and/or restraints shall be borne by the equipment manufacturer/installing contractor should submissions or installations be found to be unacceptable pursuant to the intent of this specifications.

G. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

H. Upon completion of the work, the Architect or Architect's representative shall inspect the installation and shall inform the Installing Contractor of any further work that must be completed. Make all adjustments as directed by the Architect that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

I. Manufacturer Responsibility

1. Manufacturer of vibration and seismic control equipment shall have the following responsibilities:

   a. Determine vibration isolation and seismic restraint sizes and locations.

   b. Provide equipment vibration isolation and seismic restraints as scheduled or specified.

   c. Guarantee specified isolation system deflections.

   d. Provide installation instructions, drawings and field supervision to ensure proper installation and performance of systems.

   e. Provide certification by a licensed engineer that all mounts and restraints meet the project requirements for seismic loading.

2. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed Civil or Structural Engineer.

3. Licensed Engineers shall be licensed in the project state.

J. Contractor Responsibilities

1. The Contractor performing the work on equipment in the section shall have the following responsibilities.

   a. Identify the components that are part of the Quality Assurance Plan.

      1) All flammable, combustible and highly toxic piping and their associated mechanical systems.
      2) All ductwork containing hazardous materials.
      3) All equipment using combustible or toxic energy sources.

   b. Identify all Special inspection and Testing.

   c. List control procedures within the contractor’s organization including methods and frequency of reporting and their distribution.

d. List personnel and their qualifications exercising control over the seismic aspects of the project.

2. Purchased and/or fabricated equipment must be designed to safely accept external forces of 1.8 g load in any direction for all rigidly supported equipment, piping and ductwork without failure and permanent displacement of the equipment. Resiliently supported equipment, piping and ductwork and Life safety equipment such as fire pumps, smoke exhaust fans, emergency generators and other life safety designated equipment must be capable of accepting external forces of up to 3.6 g in any direction without permanent displacement or failure of the equipment.

1.08 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping system and ASTM F708 for design and installation of pipe hangers.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. All vibration control and SEISMIC restraint equipment shall be delivered in containers and shall be kept in a dry and protected area.

C. All exposed hangers, supports, etc. shall be given 2 coats of rust resistant paint of a color selected by the Architect prior to installation.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 ISOLATORS AND RESTRAINTS – GENERAL

A. Acceptable Manufacturers subject to compliance to specifications.
   1. Kinetics Noise Control (KNC) or approved equal.

B. The Mechanical Contractor shall provide necessary vibration isolation materials to eliminate excessive noise and vibration from being transmitted from HVAC equipment to the occupied areas of the structure, and to serve as the basis for seismic restraint design for the entire HVAC system within the building. This includes all non-structural components such as, but not limited to, air handlers, fans, pumps, tanks, ductwork, piping, etc. (hereinafter called equipment).

C. Seismic restraints and vibration isolation types shall be capable of accepting, without failure, seismic forces determined in accordance with:

   1. International Building Code (2003)

   2. State/Country Codes

   3. Local codes enforced at the specified project location.

D. Isolators and supports shall maintain the equipment in a captive position and not short circuit isolation during normal operating conditions. Isolators shall have provisions for bolting and/or welding to the structure.

E. All metal parts of vibration isolation units installed out-of-doors shall be hot dip galvanized, cadmium plated, or neoprene or PVC coated after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard #14.

F. All base supported isolators shall have base plates with bolt holes for fastening the isolators to the support members.

G. Isolator types are scheduled to establish minimum standards. At the Contractor's option, laborsaving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories must not degrade the vibration isolation system.

H. Static deflection of isolators shall be as scheduled in this Section and as shown on the drawings. All static deflections stated are the minimum acceptable deflection

under actual load. Isolators shall be selected for no less than 50% reserve deflection beyond actual operating conditions.

I. Attachment plates to be cast into housekeeping pads, concrete inserts, beam clamps, etc. that may be required for seismic compliance shall be provided by this Section.

J. Coordinate the size, location and special requirements of vibration isolation equipment and systems with other Trades. Coordinate plan dimensions with size of housekeeping pads.

2.03 SEISMIC RESTRAINT TYPES

A. Type I

1. Type I shall comply with general characteristics of spring isolator Type A with snubbing restraint in all directions capable of supporting equipment at fixed elevations during installation. Cast or aluminum housings, except ductile iron are not acceptable.

2. Type I seismic restraint shall be similar to Mason Industries Type SLRS.

B. Type II

1. Each corner or side of equipment base shall incorporate a seismic restraint snubber having a minimum of 5/8" thick resilient pad limit stop. Seismic snubbers shall be in accordance with manufacturer's recommendations.

2. Type II seismic restraints shall be similar to Mason Industries Type Z-1011 or Z-1225.

C. Type III

1. Type III shall be multiple metal cable or strut type with approved fastening devices to equipment and structure. System to be field bolted to deck or to overhead structural members using 2-sided beam clamps or appropriately designed inserts for concrete. All parts of the system including cables, excluding fasteners, are to be of a single supplier to ensure seismic compliance.

D. Type IV

1. Type IV shall have double deflection neoprene isolator (minimum 0.3") encased in ductile iron or steel casing.

2. Type IV seismic restraints shall be similar to Mason Industries Type BR, RBA or RCA.

E. Type V

1. Non-isolated equipment shall be field bolted or welded (powder shots not acceptable) to the structure as required to meet seismic forces. Bolt diameter, imbedment data and/or weld length must be shown in certified calculations.

2.04 VIBRATION ISOLATOR TYPES

A. Type A (Floor Spring and Neoprene)

1. The Type A spring isolator shall:

a. Have a minimum outside diameter to overall height of 0.8:1.

b. Have corrosion resistance where exposed to corrosive environment with:

1) Springs cadmium plated or electro-galvanized.
2) Hardware cadmium plated.
3) All other metal parts hot dip galvanized.

c. Have reserve deflection (from loaded to solid height) of 50% of rated deflection.

d. Have minimum 1/4" thick neoprene acoustical base pad on underside, unless designed otherwise.

e. Be designed and installed so that ends of springs remain parallel.

2. Type A isolator shall be similar to Mason Industries Type SLF.

Note: Must be used with Seismic Restraint II.

B. Type B (Floor Spring and Neoprene Travel Limited)

1. The Type B spring isolator shall be the same as Type A with the following additional features.

a. Built-in vertical limit stops with minimum 1/4" clearance under normal operation.

b. Tapped holes in top plate for bolting to equipment.

c. Capable of supporting equipment at fixed elevation during equipment installation. Installed and operating heights shall be identical.

d. Adjustable and removable spring pack with separate neoprene isolation pad.

2. Type B isolator shall be similar to Mason Industries Type SLR.

Note: This isolator must be bolted or welded to the structure.

C. Type C (Spring Hanger Rod Isolator)

1. Spring isolator (Type A) seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.

2. Spring diameters and hanger box shall allow 30° of hanger rod movement.

3. When used on ductwork, provide eyebolts for attachment to duct straps.

4. Type C isolator shall be similar to Mason Industries Type 30 or W30.

Note: Must be used with Seismic Restraint III.

D. Type D

1. Double deflection neoprene isolator (minimum 0.3”) encased in ductile iron or steel casing.
2. Similar to Mason Industries Type BR, RBA or RCA.

E. Type E (Elastomer Hanger Rod Isolator)

1. Molded (minimum 1 3/4" thick) neoprene element with projecting bushing lining the rod clearance hole. Static deflection at rated load shall be minimum 0.035".

2. Steel retainer box encasing neoprene mounting capable of supporting equipment up to (4) times the rated capacity of the element.

3. Type E isolator shall be similar to Mason Industries Type HD.

Note: Must be used with Seismic Restraint III.

F. Type F (Combination Spring/Elastomer Hanger Rod Isolator)

1. Spring and neoprene elements in a steel retainer box with the features as described for Type C and Type E isolators.

2. Type F isolator shall be similar to Mason Industries Type 30N.

Note: Must be used with Seismic Restraint III.

G. Type G (Pad Type Elastomer Isolator)

1. 0.75" minimum thickness, 50 psi maximum loading, ribbed or waffled design.

2. Minimum 0.1" deflection.

3. 1/16" galvanized steel plate between multiple pad layers.

4. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.

5. Type G isolators shall be similar to Mason Industries Type Super W.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

H. Type H (Pad Type Elastomer Isolator)

1. Laminated cotton duck and neoprene, maximum loading 1000 psi, minimum 1/2" thick.

2. Provide load distribution plate where attachment to equipment bearing surface is less than 75% of the pad area.

3. Type H isolator shall be similar to Mason Industries Type HL.

Note: Bolting required for seismic compliance. Neoprene and duck washers and bushings shall be provided to prevent short circuiting.

I. Type I (Thrust Restraints)

1. A spring element similar to Type A isolator shall be combined with steel angles, back-up plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting movement of air handling equipment to 1/4".

2. Restraint shall be easily converted in the field from a compression type to tension type.

3. Unit shall be factory pre-compressed.

4. Thrust restraints shall be installed on all cabinet fan heads, axial or centrifugal fans and other equipment as scheduled.

5. Type I restraint shall be similar to Mason Industries Type WB.

J. Type J (Steel Rails)

1. Steel members of sufficient strength to prevent equipment flexure during operation.

2. Height saving brackets as required to reduce operating height.

3. Type J isolator shall be similar to Mason Industries Type ICS.

K. Type K (Pipe Anchors and Guides)

1. Acoustical pipe anchor or guide, consisting of a telescopic arrangement of (2) sizes of steel tubing separated by a minimum 1/2" thickness of Type H pad.

2. Vertical restraints shall be provided by a similar material arranged to prevent vertical travel in either direction (anchors only).

3. Allowable loads on isolation materials shall not exceed 500 psi, and the design shall be balanced for equal resistance in any direction.

4. Anchors and guides must be bolted or welded to meet seismic criteria.

5. Type K anchor shall be similar to Mason Industries Type ADA.

2.05 EQUIPMENT BASES

A. All curbs and roof rails are to be bolted or welded to the building steel or concrete deck to attain acceleration criteria and shall be wind restrained for 110 mph wind loads.

B. Type B-1 (Integral Structural Steel Base)

1. The integral structural steel base shall be reinforced as required to prevent base flexure at equipment start-up and misalignment of driver and driven units. Centrifugal fan bases shall be complete with motor slide rails and shall be drilled for driver and driven units.

2. Height saving brackets shall be provided, as required, to reduce operating height and maintain 1" operating clearance under base.

3. Member depth shall be a minimum of 1/10 of the longest unsupported span.

4. Type B-1 equipment base shall be similar to Mason Industries Type M or WF.

Note: Must be used with Restraint I, II or IV.

C. Type B-2 (Concrete Inertia Base)

1. Concrete inertia base shall have rectangular structural concrete forms for floating foundations. Base for split-case pumps shall be large enough to support elbows. The base depth shall be a minimum of 1/12 the longest span, but not less than 6" or greater than 14". Forms shall include concrete reinforcement consisting of 1/2" bars or angles welded in place on 6" centers both ways in a layer 1 1/2" above the bottom. Provide an additional top layer of reinforcing for all bases exceeding 10'-0" in one direction.

2. Isolators shall be set into pocket housings which are an integral part of the base construction and set at the proper height to maintain 1" clearance below the base. Base shall be furnished with templates for equipment attachment and anchor bolt sleeves.

3. Type B-2 equipment base shall be similar to Mason Industries Type K or KIPWF.

Note: Must be used with Restraint I, II or IV.

2.06 FLEXIBLE PIPE CONNECTOR

A. All flexible connectors shall be:

1. Installed on the equipment side of the shutoff valves, horizontal and parallel to equipment shafts whenever possible. All piping between the flexible connector and the equipment shall be independently supported off the equipment base.

2. Provided wherever rigidity supported piping is connected to equipment.

B. Type FC-1 (Elastomer Connector)

1. Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord.

2. Straight connectors to have (2) spheres reinforced with a molded in external ductile iron ring between the spheres.

3. Rated at 250 psig/170°F, dropping in a straight line to 170 psig/250°F for sizes 1 1/2" to 12".

4. All sizes shall employ control rods with neoprene end fittings isolated from anchor plates by means of 1/2" bridge bearing neoprene bushings.

5. Connectors shall be installed pre-extended per manufacturer's recommendations to prevent elongation under pressure.

6. Minimum safety factory of 3.6:1 at maximum pressure ratings shall be certified by test reports. Submittals shall also include (2) test reports by independent consultants showing minimum reduction of 20 dB in vibration accelerations and 10 dB in sound pressure levels at typical blade passage frequencies.

7. Connectors bolted to Victaulic type coupling or gage, butterfly or check valves to have a minimum 5/8" flange spacer installed between the connector and the coupling flange.

8. Connectors for pipe size 2" and smaller shall have threaded female union couplings on each end. Larger pipe sizes shall be fitted with flange couplings.

9. Type FC-1 flexible connector shall be similar to Mason Industries Super-Flex Type SFDEJ or SFEJ.

C. Type FC-2 (Flexible Stainless Steel Hose)

1. Stainless steel hose and braid rated with 3:1 safety factor.

2. 2" and smaller with male nipples, 2 1/2" and larger with fixed steel flanges.

3. Lengths as follows:

Size		Length	Size		Length	Size		Length
1/2	x	9	2	x	14	8	x	22
3/4	x	10	2 1/2	x	13	10	x	26
1	x	11	3	x	14	12	x	28

1 1/4	x	12	4	x	15	14	x	30
1 1/2	x	13	5	x	19	16	x	32
			6	x	20			

4. Type FC-2 flexible connector shall be similar to Mason Industries Type BSS.

5. 250 PSIG working pressure.

D. Type FC-3 (Unbraided Exhaust Hose)

1. Low pressure stainless steel annularly corrugated with flanged ends.

2. Maximum temperature of 1500°F.

3. Lengths (in inches) as follows:

Size		Length	Size		Length
2 1/2	x	15	8	x	22
3	x	16	10	x	26
4	x	17	12	x	28
5	x	18	14	x	30
6	x	19	16	x	32

4. Type FC-3 flexible connector shall be Mason Industries Type SDL-RF or equal by approved manufacturer.

E. Type FC-4 (Bronze Braided Flexible Hose)

1. Bronze hose and braid rated with a minimum 3:1 safety factor (minimum 150 psi).

2. Copper tube ends.

3. Minimum lengths (in inches) as follows:

Size		Length	Size		Length	Size		Length
1/8	x	7 1/2	3/4	x	11 1/2	3	x	27
1/4	x	8 1/4	1	x	13	3 1/2	x	32
3/8	x	9	1 1/4	x	14 3/4	4	x	33
1/2	x	9 3/4	1 1/2	x	17	5	x	41
5/8	x	10	2	x	20	6	x	48
			2 1/2	x	24			

4. Type FC-4 flexible connector shall be similar to Mason Industries Type BFF.

5. 250 PSIG working pressure.

F. Seismic Expansion Joints

1. Provide seismic expansion joints on all ducts, piping, conduits or other systems crossing building expansion seismic joints. Provide these joints to allow for the movement in the XY&Z direction as indicated on the structural documents.

2. Pressure rated for 250 PSIG at maximum service temperature.

2.07 VIBRATION ISOLATION SCHEDULE

Equipment	HP	Mtng	On Grade ****				Above Grade			
			Isol	Defl	Base	Restr	Isol	Defl	Base	Restr
Axial Fans		Flr Clg	A&I	.75	B-1	II	A** F&I	See Guide	B-2	
In Line Pump		Clg	---	---	---	---	F	.30	---	III
Cabinet Type Fans	To 1	Flr Clg	D ---	.50 ---	--- ---	IV ---	D	See Guide	--- ---	IV
Cabinet Type Fans	>1	Flr Clg	A ---	1.0 ---	--- ---	II ---	A ** F	See Guide	--- ---	I,II III
Centrifugal Fans		Flr Clg	A ---	1.0 ---	B-1 ***	II ---	A** F	See Guide	B-2 ***	I,II III
Unit/Cab. Heaters		Clg	---	---	--	--	E	.30	---	III

* Used on vertically arranged units. Rails shall be 1.5 times the unit height.
** Substitute Type B isolator for Outdoor installations.
*** Substitute Type B-2 base for floor mounted Class 2 and 3 fans.
**** "On Grade" shall mean slab on grade only.
***** Fans in all units shall be isolated in accordance with chart.

Notes:

1. "Isol", "Base" and "Restr" columns indicate letter type as appears in the specs.

2. "Mtng" refers to method of support of equipment from the structure.

3. "See Guide" indicates isolator deflection selection to be taken from Deflection Guide below.

Deflection Guide	
RPM	MW Deflection
<400	3.5"
<600	2.5"
>600	1.5"

PART 3 – EXECUTION

3.01 GENERAL

A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and submittal data. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

B. Design Criteria

1. All mechanical equipment such as pumps, heat pumps, fans, air handling units, etc. shall be isolated from the building structure by means of noise and vibration isolators.

2. All piping ductwork in mechanical equipment rooms and penthouses shall be isolated from the building structure by means of noise and vibration isolation hangers and provided with seismic restraints.

3. Piping and/or ductwork penetrations through floors and walls shall not be rigidly connected to the building structure. Provide sleeves with clearances around the outside, as recommended by the vibration materials manufacturer. All such penetrations shall be smokeproofed and firestopped in an approved manner as hereinbefore specified.

4. Generally, isolation facilities shall be designed to limit equipment room floor or roof loading to a maximum of 50 lbs./sq.ft. and vibration isolators shall be carefully and specifically selected for each piece of equipment.

5. Flexible duct connections at fans and air handling units shall have a minimum clear gap of 3" between metal collars. Flexible connectors exposed to the weather shall be weatherproofed by the Mechanical

Contractor. Refer to the Sheet Metal Section of this specification for requirements of flexible duct connections.

6. Piping found to have water hammer or other objectionable vibration or noise which cannot be eliminated by proper grading or other natural means shall be braced, trapped, hung with vibration isolation hangers, equipped with air chambers or mechanical shock absorbers, flexible pipe connectors, or otherwise silenced using means as approved by the Architect.

7. Motor driven equipment which is to be isolated shall have motor mounted on the isolated equipment or shall have motor, equipment and drive mounted on a common base.

8. The Contractor shall not install any equipment, piping or conduit which makes rigid contact with the "building" unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.

9. Isolation mounting deflection shall be (minimum) as specified or scheduled on drawings.

10. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

11. Bring to the Architect's attention, prior to installation, any conflicts with other trades that will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

12. Bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.

13. Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.

14. Correct, at no additional cost, all installations which are deemed defective in workmanship or materials.

3.02 SPRING RISER SUPPORT SYSTEM

A. All vertical riser subjected to thermal expansion and/or construction as noted herein or on the documents, shall be supported by spring isolators and central anchors designed to insure loading within design limits at structural support points. The riser design must include the initial load, initial deflection, change in deflection, final load and change in load at all spring support locations. In order to minimize load changes, the initial spring deflection must be at least 4 times the thermal movement. The submittal must also include anchor loads when installed, cold filled, and at operating temperature. Include calculated pipe stress at end conditions and branch off locations as well as installation instruction. The submittals must be stamped and signed by a licensed Professional Engineer in the employ of the vibration vendor for at least five years.

B. Neutral resilient anchors close to the center of the run shall direct movement up and down. The anchors shall be capable of holding an upward force equal to the water weight when the system is drained. If one level cannot accommodate this force, anchors can be located on 2 or 3 adjacent floors. Resilient guides shall be spaced and sized properly depending on the pipe diameter.

C. Proper provision shall be made for seismic protection in seismic zones, as required.

D. The support spring mounts shall be specification Type A, anchors Type ADA, telescoping guides Type VSG, all similar to as manufactured by Mason Industries, Inc.

E. The isolation vendor shall provide and design all brackets at riser spring and anchor locations where standard clamps lack capacity or do not fit. The contractor must install and adjust all isolators under the supervision of the designing isolation vendor or his representative.

3.03 EQUIPMENT ISOLATION INSTALLATION

A. Equipment shall be isolated and restrained as per the vibration isolation schedule at the end of this Section.

B. Place floor mounted equipment on 4" high concrete housekeeping pads (unless detailed otherwise) properly doweled or expansion shielded to the deck to meet acceleration criteria. Anchor isolators and/or bases to housekeeping pads. Housekeeping pad concrete work shall be by Division 3. Housekeeping pads shall be sized to have a minimum of 6” of clearance all around the equipment or 12 bolt diameters, whichever is greater.

C. Additional Requirements

1. The minimum operating clearance under inertia bases shall be 2".

2. The minimum operating clearance under other bases shall be 1".

3. All bases shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the equipment, isolators and restraints.

4. The isolators shall be installed without raising the equipment.

5. After the entire installation is complete, and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. The blocks shall be barely free and shall be removed. Remove all debris from beneath the equipment and verify that there are not short circuits of the isolation. The equipment shall be free in all directions.

6. Install equipment with flexibility in wiring.

3.04 PIPING AND DUCTWORK ISOLATION INSTALLATION

A. Isolate piping and ductwork outside shafts connected to rotating or reciprocating equipment and pressure reducing stations as follows:

1. All water piping in mechanical rooms.

2. Water piping within 50'-0" or 100 pipe diameters (whichever is greater) from connected isolated equipment.

B. The isolators shall be installed with the hanger box hung as closely as possible (without direct contact) to the structure.

C. The isolators shall be suspended from substantial structural members sized for a maximum deflection of L/360 at mid span, not from slab diaphragm, unless specifically permitted by the structural engineer.

D. Hanger rods shall not short circuit the hanger box.

E. Horizontal suspended water piping 1 1/4" to 2" shall be suspended by Type E isolators with a minimum 3/8" deflection. Water pipe larger than 2" shall be supported by Type F isolators with a minimum 0.75" deflection or same deflection as equipment for the first (3) locations nearest equipment, whichever is greater.

1. Type L isolators may be substituted for the above.

2. Horizontal floor and roof supported pipe shall be the same as above except use isolators Type D and Type A, respectively.

F. Ductwork shall be supported by Type C isolators with a minimum 0.75" deflection.

G. Vertical riser pipe supports, where required, under 2" diameter shall utilize Type H isolation.

H. Vertical riser guides, where required, shall avoid direct contact of piping with the building.

I. Pipe anchors or guides, where required, shall utilize Type K isolators.

J. Riser sway supports, where required, shall utilize (2) neoprene elements (Type G or H) to accommodate tension and compression forces.

K. Install Type FC-1 (FC-4 for refrigerant piping) flexible connectors at all connections of pipe to isolated equipment such as pumps, as shown on the drawings.

L. Install FC-2, FC-3 or FC-4 type connectors only at locations which exceed temperature or service (such as gas, fuel oil, or refrigerant) limitations of FC-1.

M. Emergency generator exhaust shall be provided with Type R isolators with a minimum deflection of 1" (larger deflections may be required). These isolators shall be closely coordinated with expansion and stress calculations and seismic restraints and movements.

3.05 SEISMIC RESTRAINTS INSTALLATION

A. All floor mounted equipment, whether isolated or not, shall be bolted or welded to the structure to allow for required acceleration. Bolt points, diameter of inserts, imbedment depth and weld length as shown on approved submittal drawings shall be followed in all respects.

B. All suspended equipment shall be 2-point or 4-point independently braced with Type III restraints, installed taut for non-isolated equipment, such as piping or ductwork and slack with 1/2" cable deflection for isolated equipment. Note: Stiffeners for support rods may be required, certifications shall clearly delineate when such stiffening is required or not.

1. Piping Bracing: Schedule 10 thru 40 welded, screwed, flanged or grooved; 40'-0" maximum transversely, 80'-0" maximum longitudinally, and within 4'-0" each change of direction. No- hub piping shall be at 10’-0” intervals or 40’-0” if 1.0 g couplings are used.

2. Ductwork Bracing: 30'-0" maximum, transversely, 60'-0" maximum longitudinally, and within 4'-0" of each change of direction.

C. Seismic restraints are not required:

1. Only when explicitly permitted by the code. These permitted exceptions shall be detailed clearly on the first page of the seismic submittal.

D. Seismic restraints are not required on the following (there are no exceptions for piping containing flammable or hazardous material or connected to life/safety equipment):

1. Piping in mechanical equipment rooms less than 1 1/4".

2. Other piping less than 2 1/2".

3. All rectangular ducts less than 6 sq.ft. in cross sectional areas.

4. All round ducts less than 28" diameter.

5. All pipe suspended by individual hangers 12" in length or less from the top of the pipe support to the bottom of the support for the hanger.

6. All top supported ducts suspended by hangers 12" or less in length from the top of the duct to the bottom of the support for the hanger.

E. Where base anchoring of equipment is insufficient to resist seismic forces, restraints such as Type III shall be located above the unit's center of gravity to resist "G" forces.

Note: Vertically mounted tanks and upblast tubular centrifugal fans may require this additional restraint.

F. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:

1. Upper flanges of structural beams.

2. Upper truss chords in bar joists.

3. Cast-in-place inserts or drilled and shielded inserts in concrete structures.

G. Chimneys and stacks passing through floors are to be bolted at each floor level or secured above and below each floor with riser clamps or approved vibration isolation systems with seismic restraints.

H. Chimneys and stacks running horizontally to be braced every 30 ft (9 m) with Type III restraining system.

I. Inspection

1. On completion of installation of all vibration isolation and seismic restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

2. Provide all special inspections in accordance with IBC and as specified herein.

a. Continuous inspection: The full-time observation of work by an approved special inspector pursuant to IBC. The following pieces of equipment require these inspections:

1) All equipment using combustible or toxic energy sources.
2) All electric motors and motor control centers.
3) Reciprocating and rotating type machinery.
4) Pipe.
5) Tanks, heat exchangers & pressure vessels.
6) Ductwork.

b. Periodic inspection: Provide intermittent observation of work by an approved special inspector of the following pieces of equipment in compliance with IBC.

1) All smoke control systems during construction & prior to concealment for leakage testing.

2) Isolator units for seismic isolation system.

3) All flammable, combustible and highly toxic piping and their associated mechanical systems.

4) All ductwork containing hazardous materials.

c. After all inspections a written report shall be provided.

3.06 INSTALLATION INSTRUCTIONS

A. Adjust all base and piping isolators as required to prevent stress transfer to equipment.

B. Set steel bases for 1" clearance between housekeeping pad and base. Set concrete inertia bases for 2" clearance. Adjust equipment level.

C. Position equipment, structural base and concrete base on blocks or wedges at proper operating height.

D. Provide all equipment and provide operating load conditions before transferring base isolation loads to springs and removing wedges.

E. Install inertia bases of type and thickness, with isolators of type and static deflection indicated.

F. Provide isolators as specified and install in accordance with the manufacturers recommendations. Seismic restraints shall not be installed until isolators are adjusted and equipment height is finalized.

G. Provide forms for 4" high housekeeping pads under all floor mounted equipment, including those with inertia blocks. Provide necessary reinforcing.

H. Install equipment with flexibility in wiring connection.

I. Verify all installed isolators and mounting system permit equipment motion in all directions.

J. Adjust or provide additional resilient restraints to flexibly limit lateral motion to 1/4" during start-up of equipment.

K. Before start-up, clean out all foreign matter between bases and equipment to prevent short circuit.

L. Install flexible pipe connectors on pipe connected to equipment supported by vibration isolation. Hook up piping to equipment and mains with spool pieces. After completion of pressure testing but prior to start-up, remove spool pieces and install flexible pipe connectors. Identify spool pieces as to equipment served and either entering or leaving.

M. Provide seismic displacement joints for all piping, ductwork and conduits crossing building expansion joints or building seismic joints.

3.07 CERTIFICATION

A. Upon completion of installation of all vibration isolation devices and seismic restraints, the Mechanical Contractor shall hire an independent Seismic Professional Engineer to visit the site, inspect the completed project and certify in writing to the Architect that all systems are installed properly, or require correction.

END OF SECTION 230598

SECTION 230713 – DUCT INSULATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all duct insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete and insulated system of all ductwork, fittings, joints, offsets and accessories specified herein.

B. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Steel and Plate.

2. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and plate (Metric).

3. ASTM C 518 – Standard Test method for Steady-State Heat Flux Measurements and Thermal Insulating and Finishing Cement.

4. ASTM C 553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

5. ASTM C 612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

6. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

7. ASTM C 1071 – Standard Specification for Thermal and Acoustical Insulation (Glass, Fiber, Duct Lining Material).

8. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

9. ASTM E 96 – Standard Test Methods for Water Vapor Transmission of Materials.

10. ASTM E 162 – Standard Test Method for Surface flammability of Materials Using a Radiant Heat Energy Source.

11. ASTM G 21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

12. NFPA 96 – Ventilation Control and Fire Protection of Commercial Cooking Operations.

13. NFPA 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials.

14. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.

15. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

16. ANSI/ASHRAE 90.1 - Energy Conservation in New Building Design.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. See Section 230500 for additional requirements.

D. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

E. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. All insulation materials, finishes, coatings, cements, tapes, jackets and other insulation accessories shall have minimum composite or individual fire hazard ratings as well as thickness and "C" values conforming to State Building Codes which control building construction materials that may be used on this project. Where specification requirements exceed the Code requirements, the specification shall govern.

C. Insulation for the various duct systems and associated equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:

1. Flame Spread Rating: 25 (No Exceptions)
2. Smoke Developed Rating: 50

D. All fire hazard ratings shall be as determined by NFPA 255 "Method of Test of Surface Burning Characteristics of Building Materials", ASTM E84 or UL 723.

E. All insulation materials herein specified shall be used subject to the manufacturer's temperature limitations and their compatibility with other materials.

F. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.

G. The finished installation shall present a neat and workmanlike appearance with all jackets smooth, with all vapor barriers sealed and intact.

H. Where insulation is specified for ductwork, insulate similarly all collars, dampers, edges, joints, etc. connected to system subject to heat loss or gain. Do not cover damper actuators or other maintenance points on equipment unless identified on the insulation with removable access panels or covers.

1.08 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84, NFPA 255, or UL 723.

1.09 DELIVERY, STORAGE AND PROTECTION

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Accept materials on site, labeled with manufacturer’s identification, product density and thickness.

C. All materials shall be stored in a dry area free from moisture and debris.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during and after installation for minimum of 24 hours.

PART 2 – PRODUCTS

2.01 BUY AMERICA POLICY

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

A. Insulation:

1. Manville Corporation or approved equal.

B. Mastics and adhesives:

1. Childers Products Company or approved equal.

2.03 FACED FLEXIBLE FIBER GLASS INSULATION

A. Faced flexible fiber glass duct insulation shall be equal and equivalent to Owens-Corning Fiberglas Faced Duct Wrap, Series ED 100, FRK-25 having an approximate density of 1.0 lb./cu.ft. and an approximate thermal conductivity of 0.30 at 75° F.

B. Insulation shall be tightly wrapped on the duct work with all circumferential joints butted and longitudinal joints laped 2 inches and stapled. All joints shall be sealed with approved adhesive. Adhere insulation to ducts with 4 inch wide strips of an approved bonding adhesive, at 18 inches on center. Additionally, secure insulation to bottom of rectangular ducts over 24 inches wide with weld pins or stickclips at no more than 18 inches on center. Alternative means of securing insulation to ducts will be permitted, subject to the manufacturer's recommendations and the Architect's written approval.

C. Insulation shall be butted with facing overlapping all joints at least 2 inches and sealed with approved fire retardant vapor barrier adhesive. All breaks, punctures and pin penetration in facing, shall be sealed with vapor barrier tape per the manufacturer’s published installation instructions.

2.04 INSULATION FACING

A. Code ASJ: All service jacket composed of high intensity white chemically treated Kraft paper reinforced with fiberglass yarn and mesh and laminated to aluminum foil with a fire retardant adhesive. Longitudinal laps and butt strips shall be a minimum of 3 inches.

B. Code FSKL: 0.35 mil aluminum foil reinforced with fiberglass yarn reinforcing scrim and laminated to chemically treated fire resistive Kraft paper having a minimum 35 pound per inch width tensile strength when tested in accordance with ASTM D 828. Water vapor permeability 0.04 perms. Longitudinal laps and butt strips shall be a minimum of 3 inches.

2.05 ADHESIVES

A. Code ADH-1: Fibrous adhesive, non-flammable, quick setting adhesive for calcium silicate. Similar to Childers CP-97, 98.

B. Code ADH-2: Fast-drying vinyl base coating and lagging adhesive. Similar to Childers CP-50A HV2.

C. Code ADH-3: Fast-drying neoprene base adhesive for lap joints of foil-faced facing applied over pipe insulation. Similar to Childers CP-82.

D. Code ADH-4: Adhesive for use in adhering fiberglass board or blanket insulation to pipe and equipment. 3M Company Insulation Adhesive No. 35 or 38 non-flammable adhesive.

2.06 CAULKING COMPONENTS

A. Code CC-1: For use with foam glass and/or joint sealant applications. Flexible elastomeric vapor barrier sealant. Similar to Childers CP-76.

2.07 MASTICS

A. Code MAS-1: Vapor barrier mastic made with an elastomeric resin. For indoor use. Similar to Childers CP-30.

B. Code MAS-2: A non-water vapor barrier asphaltic emulsion coating, breathing type, for above ground installations. Similar to Childers CP-10.

C. Code MAS-3: Vapor barrier mastic made with an elastomeric resin. For outdoor use.

2.08 TIE WIRE

A. Tie wire for securing insulation in place shall be type 304 stainless steel annealed steel wire of gauge and proper spacing as recommended by the insulation manufacturer. Wire shall be drawn up tightly enough to become embedded in the insulation and the ends of the loop twisted, bent over, and pressed into the insulation so as to leave no ends protruding.

2.09 BANDING

A. 3/8 inch x 0.02 inch type 304 stainless steel for pipe insulation.

B. 3/4 inch x 0.02 inch type 304 stainless steel for additional insulation jackets.

2.10 WIRE MESH

A. Wire mesh shall be one inch by No. 20 BGW hexagonal mesh galvanized.

B. Expanded metal: Expanded metal shall be 1/2 inch Hi-Rib metal lath of copper bearing steel.

2.11 TAPE

A. Lead foil tape, where specified, shall be 3M Company Lead Foil Tape No. 422, 4 mil thick, acrylic adhesive, 2 inch wide.

B. Vinyl plastic tape, silver gray, flame resistant, vapor barrier sealant tape on rigid and flexible insulation material for warm or cold air ducts. Similar to 3M Company Duct Sealing Tape No. 474.

C. Aluminum foil tape, dead soft aluminum foil, point seal on stick pin, metal patching, moisture barrier, heat reflecting and general sealing on aluminum facing foil. Similar to 3M Company Aluminum Foil Tape No. 425.

2.12 STAPLES

A. Staples shall be galvanized clad outward clinching insulation staples.

2.13 INSULATING CEMENT

A. Insulating cement shall be a mineral-fiber (wool) ASTM C 195 base material having essentially the same insulating characteristics as the adjacent insulation. Similar to PABCO High Temperature Insulating Cement. Insulating cement shall be applied in layers to a maximum thickness of 1/2 inch. Each layer shall be allowed to dry thoroughly before subsequent layers are applied.

2.14 FINISHING CEMENT

A. Finishing cement ASTM C 449 shall be diatomaceous silica thermal insulating materials with a suitable proportion of heat resistant binder, hydraulic setting insulating cement capable of withstanding maximum temperature of 700 degrees Fahrenheit. When mixed with water it shall be a plastic mix suitable for trowel applications and shall present a hard, smooth and durable surface after drying. Similar to PABCO No. 127.

B. Combination insulating and finishing cement:

1. Similar to Ryder One Coat or equal.

C. Welding studs:

1. Welding studs shall be capacitor type split pin or TCP tipped insulation pins with speed clips. Similar to Nelson Stud Welding Spec. 28.

D. Corner angles on insulation of ducts, plenums and equipment in finished areas shall be formed of 28 gauge, 1 inch by 1 inch aluminum adhered to heavy Kraft paper having 2 inch by 2 inch by 2 inch wings to protect external corners under glass cloth jackets.

1. Corner beads shall be 26 gauge galvanized steel with 2 ½ inch wings (exposed ducts on roof).

PART 3 – EXECUTION

3.01 INSTALLATION OF INSULATION

A. All insulation shall be applied by experienced insulating contractors in accordance with best Trade practice.

B. Test, inspect and clean all surfaces of ductwork to be insulated before applying insulation.

C. Take all possible precautions to protect work of other Trades. Provide protective covering as required to accomplish this end. This Trade shall be responsible for returning all equipment and material to its original new condition and appearance where damage occurs due to his neglect.

D. All ductwork shall have been tested and approved prior to installation of insulation.

E. All ductwork and plenum or surfaces, where subject to condensation on the outside, shall be insulated including vapor seal finish.

F. All surfaces to be insulated shall be clean, dry and free from dirt and scale when insulation is being applied. Insulation shall be dry at the time of installation and before and during the process of finished application.

G. Butt ends will not be allowed. However, where required and approved by Architect, jacket material shall be pasted over exposed ends and banded to give a neat and finished appearance. Exposed fiberglass material will not be permitted.

H. Surfaces of insulation shall be smooth, even and true to line with jackets drawn tight and smoothly secured. Scrap pieces of insulation shall not be used where a full length section will fit.

I. The methods of application of insulation, finishes, adhesives, cements, accessories are generally specified under the material headings of these specifications. Where not specifically detailed, it is intended that they are equal or exceed the manufacturer's published recommendations, existing at time of bid openings, subject to the approval of the Architect.

J. Butt covering neatly to walls, floors, ceiling. Apply band at end and position so band covers gap between surface and insulation where exposed.

K. Fastenings: Provide where required to securely hold insulation. Apply adhesive and weld pins and/or stick clips on exposed risers to prevent slipping and turning of insulation. .

L. Thickness of insulation shall not be compromised due to piping interferences, improper installation or any other reason.

PART 4 – SCHEDULES

4.01 DUCTWORK INSULATION SCHEDULE:

Service	Type Insulation and Thickness (Inches)	Facing	Additional Jacket
All Exhaust Air Ductwork	Flexible Fiberglass w/Vapor Barrier 2"	FSKL	
Louver Blank-off Panels	Rigid Fiberglass Board Insulation 3"	FSKL	
Others not scheduled with system temperatures below 60°F or above 90°F	Flexible Fiberglass w/Vapor Barrier 1"	FSKL	

A. HVAC Insulation Schedule Notes

1. Provide vapor barrier on all ductwork insulation.

2. R=5 installed equals 2" flexible fiberglass.

END OF SECTION 230713

SECTION 230716 – EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all equipment insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete and insulated system of all equipment, flanges and accessories as specified herein.

B. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.

C. Where equipment has removable heads, then insulation shall have removable insulated covers. Do not cover any equipment nameplates.

D. Insulate the following

1. All equipment and accessories shall be insulated as herein specified.

2. Exhaust fans serving to bridge ventilation compression tanks, air separators.

3. Pressure reducing valves.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.

2. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Steel and Plate.

3. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and plate (Metric).

4. ASTM C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by

5. Means of the Guarded Hot Plate Apparatus

6. ASTM C 195 – Standard Specification for Mineral Fiber Thermal Insulating Cement.

7. ASTM C 240 – Standard Test Methods of Testing Cellular Glass Insulation Block.

8. ASTM C 449/C 449M – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

9. ASTM C 518 – Standard Test method for Steady-State Heat Flux Measurements and Thermal Insulating and Finishing Cement.

10. ASTM C 533 – Standard Specification for Calcium Silicate Block and Pipe Terminal Insulation.

11. ASTM C 534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

12. ASTM C 552 – Standard Specification for Cellular Glass Thermal Insulation.

13. ASTM C 553 – Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

14. ASTM C 592 – Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).

15. ASTM C 612 – Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

16. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

17. ASTM D 1056 – Standard Specification for Flexible Cellular Materials – Sponge ore Expanded Rubber.

18. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

19. ASTM E 96 – Standard Test Methods for Water Vapor Transmission Materials.

20. NFPA 225 – Standard Method of Test of Surface Burning Characteristics of Building Materials.

21. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

22. ANSI/ASHRAE 90.1 - Energy Conservation in New Building Design

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. See Section 230500 for additional requirements.

D. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

E. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

F. Contractor's Installation Details

1. Submit job specific details and/or drawings indicating methods of insulating specific pieces of equipment such as but not limited to, chilled water pumps, steam turbines, condensate receivers, exposed roof-top piping, etc.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. All insulation materials, finishes, coatings, cements, jackets and other insulation accessories shall have minimum composite or individual fire hazard ratings as well as thickness and "C" values conforming to State Building Codes which control building construction materials that may be used on this project. Where specification requirements exceed the Code requirements, the specification shall govern.

C. Insulation for the equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:

1. Flame Spread Rating: 25 (No Exceptions)

2. Smoke Developed Rating: 50

D. All fire hazard ratings shall be as determined by NFPA 255 "Method of Test of Surface Burning Characteristics of Building Materials", ASTM E84 or UL 723.

E. All insulation materials herein specified shall be used subject to the manufacturer's temperature limitations and their compatibility with other materials.

F. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.

G. The finished installation shall present a neat and workmanlike appearance with all jackets smooth, with all vapor barriers sealed and intact.

1.08 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84, NFPA 255, or UL 723.

B. Conform to local Energy code.

1.09 DELIVERY, STORAGE AND PROTECTION

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Accept materials on site, labeled with manufacturer's identification, product density and thickness.

C. All materials shall be stored in a dry area free from moisture and debris.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during and after installation for minimum of 24 hours.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

1. Insulation:

a. Manville Corporation or approved equal.

2. Mastics and adhesives:

a. Childers Products Company or approved equal.

3. Reusable covers

a. Insulation Technology, Inc or approved equal.

2.03 MATERIALS AND COMPONENTS

A. Calcium Silicate Block Insulation

1. Calcium silicate block insulation shall be Owens-Corning, Kaylor or Manville Thermo-12. Insulation shall have a density of 11 lbs./cu.ft., a thermal conductivity of 0.37 at 200°F mean temperature, and shall be suitable for application on surfaces which reach 1200°F.

2. All block insulation shall be applied in layers not exceeding 1 1/2 inches thick. Insulation shall be secured with wire and covered with 1/2 inch thick finishing cement. All corners of insulation shall be protected by metal corner beads.

3. Nameplates and inspection stamps shall not be covered. 26 gauge galvanized metal collars shall be provided at manhole and openings for controls and nameplates and stamps and the covering shall be neatly finished thereto.

B. Insulkote

1. Insulkote ST as manufactured by Manville, shall be applied on dry cement (no primer is required). Hexagonal wire mesh reinforcement shall be used. Troweling should be done firmly to make sure the coating is thoroughly forced through the mesh. Material shall not be applied in thicknesses greater than 1/8 inch. Application to a greater thickness may cause slumping while there is still solvent in the coating.

2. Wire mesh reinforcement shall be provided.

3. Insulation material and application shall be in strict accordance with the manufacturer’s procedures and recommendations.

C. Sound Barrier Composites for Bridge Exhaust Fan insulation:

1. Barymat BM-1C composites incorporate a limp, dense and heavy plastic layer (1.6 lb/S.F.).

2.04 INSULATION FACING

A. Code ASJ: All service jacket composed of high intensity white chemically treated Kraft paper reinforced with fiberglass yarn and mesh and laminated to aluminum foil with a fire retardant adhesive. Longitudinal laps and butt strips shall be a minimum of 3 inches.

B. Code FSKL: 0.35 mil aluminum foil reinforced with fiberglass yarn reinforcing scrim and laminated to chemically treated fire resistive Kraft paper having a minimum 35 pound per inch width tensile strength when tested in accordance with ASTM D 828. Water vapor permeability 0.04 perms. Longitudinal laps and butt strips shall be a minimum of 3 inches.

2.05 ADDITIONAL INSULATION JACKET

A. ADJ-1: Approximately 6 ounce per square yard glass cloth jacket with thread count of 5 strands per square inch.

B. ADJ-2: Approximately 2 ounce per square yard glass cloth jacket with thread count of 10 strands by 10 strands per square inch. Jacket shall be used for covering pipe and pipe fittings.

C. ADJ-3a: 0.016 inch thick embossed aluminum jacket conforming to ASTM B-209 with a 1 mil factory applied polykraft moisture barrier. Longitudinal joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 1 mil polykraft or acrylic vapor barrier.

D. ADJ-3b: 0.020 inch thick embossed aluminum jacket confirming to ASTM B-209 with a 1 mil factory applied polykraft moisture barrier. Longitudinal joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 1 mil polykraft or acrylic vapor barrier.

E. ADJ-4: 20 mil PVC jacket suitable for all types of paint. Similar to Manville Zeston 25/50.

F. ADJ-6 A finish jacket of an Asbestos-free and woven as high temperature, heat-resistant fabric. Lagging Cloth having a treated weight of 24 oz./sq.yd. Material shall be suitable for a sustained operation at 1100°F.

G. ADJ-7 0.16-inch thick type T-316 stainless steel jackets. Alloys shall form to ASTM A-240. System shall have a 3-mil polycraft barrier.

2.06 ADHESIVES

A. Code ADH-1: Fibrous adhesive, non-flammable, quick setting adhesive for calcium silicate. Similar to Childers CP-97, 98.

B. Code ADH-2: Fast-drying vinyl base coating and lagging adhesive. Similar to Childers CP-50A HV2.

C. Code ADH-3: Fast-drying neoprene base adhesive for lap joints of foil-faced facing applied over pipe insulation. Similar to Childers CP-82.

D. Code ADH-4: Adhesive for use in adhering fiberglass board or blanket insulation to pipe and equipment. 3M Company Insulation Adhesive No. 35 or 38 non-flammable adhesive.

2.07 CAULKING COMPONENTS

A. Code CC-1: For use with foam glass and/or joint sealant applications. Flexible elastomeric vapor barrier sealant. Similar to Childers CP-76.

2.08 MASTICS

A. Code MAS-1: Vapor barrier mastic made with an elastomeric resin. For indoor use. Similar to Childers CP-30.

B. Code MAS-2: A non-water vapor barrier asphaltic emulsion coating, breathing type, for above ground installations. Similar to Childers CP-10.

C. Code MAS-3: Vapor barrier mastic made with an elastomeric resin. For outdoor use.

2.09 TIE WIRE

A. Tie wire for securing insulation in place shall be type 304 stainless steel annealed steel wire of gauge and proper spacing as recommended by the insulation manufacturer. Wire shall be drawn up tightly enough to become embedded in the insulation and the ends of the loop twisted, bent over, and pressed into the insulation so as to leave no ends protruding.

2.10 BANDING

A. 3/8 inch x 0.02 inch type 304 stainless steel for pipe insulation.

B. 3/4 inch x 0.02 inch type 304 stainless steel for additional insulation jackets.

2.11 WIRE MESH

A. Wire mesh shall be one inch by No. 20 BGW hexagonal mesh galvanized.

B. Expanded metal: Expanded metal shall be 1/2 inch Hi-Rib metal lath of copper bearing steel.

2.12 TAPE

A. Lead foil tape, where specified, shall be 3M Company Lead Foil Tape No. 422, 4 mil thick, acrylic adhesive, 2 inch wide.

B. Vinyl plastic tape, silver gray, flame resistant, vapor barrier sealant tape on rigid and flexible insulation material for warm or cold air ducts. Similar to 3M Company Duct Sealing Tape No. 474.

C. Aluminum foil tape, dead soft aluminum foil, point seal on stick pin, metal patching, moisture barrier, heat reflecting and general sealing on aluminum facing foil. Similar to 3M Company Aluminum Foil Tape No. 425.

2.13 STAPLES

A. Staples shall be galvanized clad outward clinching insulation staples.

2.14 INSULATING CEMENT

A. Insulating cement shall be a mineral-fiber (wool) ASTM C 195 base material having essentially the same insulating characteristics as the adjacent insulation. Similar to PABCO High Temperature Insulating Cement. Insulating cement shall be applied in layers to a maximum thickness of 1/2 inch at one time. Each layer shall be allowed to dry thoroughly before subsequent layers are applied.

2.15 FINISHING CEMENT

A. Finishing cement ASTM C 449 shall be diatomaceous silica thermal insulating materials with a suitable proportion of heat resistant binder, hydraulic setting insulating cement capable of withstanding maximum temperature of 700 degrees Fahrenheit. When mixed with water it shall be a plastic mix suitable for trowel applications and shall present a hard, smooth and durable surface after drying. Similar to PABCO No. 127.

B. Combination insulating and finishing cement:

C. Similar to Ryder One Coat or equal.

2.16 WELDING STUDS

A. Welding studs shall be capacitor type split pin or TCP tipped insulation pins with speed clips. Similar to Nelson Stud Welding Spec. 28.

2.17 ACCESSORIES AND FASTENING MATERIALS

A. Corner angles on insulation of equipment in finished areas shall be formed of 28 gauge, 1 inch by 1 inch aluminum adhered to heavy Kraft paper having 2 inch by 2 inch by 2 inch wings to protect external corners under cloth jackets.

2.18 REMOVABLE/REUSABLE INSULATION COVERS

A. Pressure reducing valves operating above 200°F shall be insulated with reusable insulation covers as described in this specification.

B. The materials, construction techniques and methods of application described in this specification are for conservation of heat, ease of maintenance and personnel protection.

C. Reusable insulation covers shall be custom built and shall conform to the shape of the fitting or valve being insulated.

D. Identification of reusable covers shall be by means of a permanently attached, stainless steel tag secured to the outer surface of the cover. The identification legend, which shall be mechanically embossed on the tag, shall locate the fitting the cover was designed for. It shall also contain information adequate to reorder the cover from the manufacturer.

E. Reusable covers shall be similar to Insulation Technology, Inc., Heat Holder LD-1000, 2 inch thick fiber glass mat insulation. LD-1000 shall be an off-white color, have non-combustible wool with long, resilient, inorganic glass fibers, and shall be bonded with a thermosetting resin. Insulation shall be encased in an inner and outer jacket of 550T Teflon impregnated fiberglass fabric suitable for temperatures up to 500°F. Fabric shall weigh a minimum of 14 oz./sq.yd. and have a nominal thickness of 0.013 inch. Fabric shall also pass UL 214 Flammability Test. Fabric color shall be gray.

F. Covers shall be sewn simultaneously with (2) parallel rows of double sewn seams of (10) stitches per inch. Stainless steel quilting pins and hooks shall be included on each cover.

G. Covers shall be installed after adjacent pipe and fitting insulation and jacketing is in place. Covers shall be overlapped a minimum of 2 inches on pipe insulation. Once in place, covers shall be tightened by Velcro straps sewn into each cover.

PART 3 – EXECUTION

3.01 INSTALLATION OF INSULATION

A. All insulation shall be applied by experienced Insulating Contractors in accordance with best Trade practice.

B. Do not cover vent petcocks, grease fittings or other maintenance points on equipment unless identified on the insulation with removable access panels or covers.

C. No equipment nameplates shall be covered. The insulation shall be cut back and a 26 galvanized “picture frame” installed to accept the abutting edges of the insulation to leave the nameplate data exposed to view.

D. Test, inspect and clean all surfaces to be insulated before applying insulation.

E. Take all possible precautions to protect work of other Trades. Provide protective covering as required to accomplish this end. This Trade shall be responsible for returning all equipment and material to its original new condition and appearance where damage occurs due to his neglect.

F. All equipment and accessories shall have been tested and approved prior to installation of insulation.

G. All equipment surfaces, where subject to condensation or heat loss on the outside, shall be insulated.

H. All surfaces to be insulated shall be clean, dry and free from rust and scale when insulation is being applied. Insulation shall be dry at the time of installation and before and during the process of finished application.

I. Butt ends will not be allowed. However, where required and approved by Architect, jacket material shall be pasted over exposed ends and banded to give a neat and finished appearance. Exposed insulation material will not be permitted.

J. Surfaces or insulation shall be smooth, even and true to line with jackets drawn tight and smoothly secured. Scrap pieces of insulation shall not be used as filler pieces.

K. The methods of application of insulation, finishes, adhesives, cements, accessories are generally specified under the material headings of these specifications. Where not specifically detailed, it is intended that they are equal or exceed the manufacturer’s published recommendations, existing at time of bid openings, subject to the approval of the Architect.

L. Butt covering neatly to walls, floors, ceiling. Apply band at end and position so band covers gap between surface and insulation where exposed.

M. Fastenings: Provide where required to securely hold insulation.

N. Thickness of insulation shall not be compromised due to interferences, improper installation or any other reason.

PART 4 – SCHEDULES

4.01 EQUIPMENT INSULATION SCHEDULE

Service	Type Insulation and Thickness (Inches)	Facing	Additional Jacket
All Expansion, Compression Tanks and Air Separators	Calcium Silicate Block 1		ADJ-6
Hot water pumps	Fiberglass 3		Same as piping
Bridge Exhaust Fans	Sound Barrier Composite (1.6 lb./S.F.)		ADJ-6
Pressure Reducing Valves	Custom Cover Fiberglass Mat 2	Heat-Holder LD-1000	
Other	Fiberglass 3	FSKL	Same as piping

A. HVAC Insulation Schedule Notes

1. Refer to jacket specifications for finish covering to be installed on calcium silicate insulation in finished areas.

2. Where "Finishing Cement" finishes are scheduled, refer to specifications for Cement herein for materials, method of application, thickness, etc.

END OF SECTION 230716

SECTION 230719 – HVAC PIPING INSULATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all piping insulation, vapor barriers, jackets, finishes, adhesives, cements and accessories to make a complete insulated system for all piping, valves, fittings, joints, offsets and flanges specified herein.

B. All insulation system materials shall conform to the maximum flame spread/smoke developed ratings specified herein.

C. Hard insulation material shall be provided at all hangers.

D. Insulate the following:

1. All scheduled piping, all valves, fittings, elbows, flanges and accessories.

2. All piping exposed to weather including provision of additional weatherproof jacket.

3. All cold water make-up piping and valves. All drain and overflow piping receiving cold water. Piping to/from expansion/compression tanks.

4. All vents and blow-offs in mechanical rooms and elsewhere within reach of personnel.

5. Emergency generator piping and entire exhaust systems.

6. Piping jacket covers.

7. All heat traced piping.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Section of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.

2. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Steel and Plate.

3. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and plate (Metric).

4. ASTM C 177 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.

5. ASTM C 195 – Standard Specification for Mineral Fiber Thermal Insulating Cement.

6. ASTM C 240 – Standard Test Methods of Testing Cellular Glass Insulation Block.

7. ASTM C 449/C 449M – Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

8. ASTM C 518 – Standard Test method for Steady-State Heat Flux Measurements and Thermal Insulating and Finishing Cement.

9. ASTM C 533 – Standard Specification for Calcium Silicate Block and Pipe Terminal Insulation.

10. ASTM C 534 – Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

11. ASTM C 547 – Standard Specification for Mineral Fiber Pipe Insulation.

12. ASTM C 552 – Standard Specification for Cellular Glass Thermal Insulation.

13. ASTM C 578 – Standard Specification for Preformed, Cellular Polystyrene Thermal Insulation.

14. ASTM C 591 – Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

15. ASTM C 610 – Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.

16. ASTM C 795 – Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

17. ASTM C 921 – Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

18. ASTM D 1056 – Standard Specification for Flexible Cellular Materials – Sponge ore Expanded Rubber.

19. ASTM D 1667 – Standard Specification for Flexible Cellular Materials – vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).

20. ASTM D 1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

21. ASTM D 2842 – Standard Test Method for Water Absorption of Rigid Cellular Plastics.

22. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

23. ASTM E 96 – Standard Test Methods for Water Vapor Transmission Materials.

24. NFPA 225 – Standard Method of Test of Surface Burning Characteristics of Building Materials.

25. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

26. ANSI/ASHRAE 90.1 – Energy Conservation in New Buildings.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. See Section 230500 for additional requirements.

D. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

E. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

F. Installation Graphic Details.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. All insulation materials, finishes, coatings, cements, jackets and other insulation accessories shall have minimum composite or individual fire hazard ratings as well as thickness and "C" values conforming to State Building Codes which control building construction materials that may be used on this project. Where specification requirements exceed the Code requirements, the specification shall govern.

C. Piping insulation for the various piping systems and associated equipment shall be composed of materials which are non-combustible and/or provide a fire resistive system of insulation which complies with the applicable Code having jurisdiction. Generally, it is required that fire hazard ratings shall not exceed the following, except as noted:

1. Flame Spread Rating 25 (No Exceptions)

2. Smoke Developed Rating: 50

D. All fire hazard ratings shall be as determined by NFPA 255 "Method of Test of Surface Burning Characteristics of Building Materials", ASTM E84 or UL 723.

E. All insulation materials herein specified shall be used subject to the manufacturer's temperature limitations and their compatibility with other materials.

F. Installation of all insulation work shall be executed by a qualified Insulation Contractor who is thoroughly experienced in this particular type of work and who has adequate facilities and equipment for installation of all insulation work herein specified and who is familiar with the requirements of the Code enforcing Authorities as to fire hazard rating.

G. The finished installation shall present a neat and workmanlike appearance with all jackets smooth, with all vapor barriers sealed and intact.

H. Where insulation is specified for piping, insulate similarly all connections, vents, drains and any piping connected to system subject to heat loss or gain. Do not cover vent petcocks, cleanouts or other maintenance points on equipment unless identified on the insulation with removable access panels or covers.

1.08 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E 84, NFPA 255, or UL 723.

1.09 DELIVERY, STORAGE AND PROTECTION

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Accept materials on site, labeled with manufacturer’s identification, product density and thickness.

C. All materials shall be stored in a dry area free from moisture and debris.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during and after installation for minimum of 24 hours.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

A. Insulation:

1. Manville Corporation or approved equal.

B. Mastics and adhesives:

1. Childers Products Company or approved equal.

C. Pipe insulation of hanger and support:

1. Pipe Shields, Inc. or approved equal.

D. PVC fitting covers:

1. Manville, Corporation or approved equal.

2.03 GENERAL

A. Adhesives and insulation materials: Composite fire and smoke hazard ratings maximum 25 for flame spread and 50 for smoke developed for pipe insulation. Adhesives to be waterproof when cured.

B. The installation of thermal insulating materials coverings and coatings containing asbestos fibers is forbidden.

C. Insulation shall not be chemically reactive to the metal over which it is applied. Insulation installed on steel shall be neutral or slightly alkaline. Insulation installed on aluminum shall be neutral or slightly acidic.

2.04 MATERIALS AND COMPONENTS

A. Fiberglass insulation:

1. Premolded pipe fiberglass: Recommended temperature to 850 degrees Fahrenheit with facing. Molded in one piece split or hinged circular

sections in three foot lengths for piping and tubing. Insulation shall be made from long, fine, glass fibers bonded together with a thermosetting resin. Insulation shall have a minimum density of 4.0 pounds per cubic foot and a K value of 0.23 at 75 degrees Fahrenheit mean temperature. Insulation furnished with facing as specified below and as indicated in insulation schedule. Insulation similar to Owens-Corning Type SSL-II. Pressure sensitive tapes using rubber based or acrylic based adhesives are not permitted.

2. Pipe and tank fiberglass: Recommended temperature to 450 degrees F with facing. Insulation shall be made from long, fine, glass fibers bonded together with a thermosetting resin. Insulation shall have a minimum density of 3 pounds per cubic foot and a k-valve of 0.27 btu in/(Hr sq.ft. degree F) at 75 degrees F main temperature. Insulation furnished with facing as specified below and as indicated in insulation schedule. Insulation similar to Manville pipe and tank insulation. Pressure sensitive tapes using rubber based or acrylic based adhesives are not permitted.

3. Flexible fiberglass: Recommended temperature to 250 degrees Fahrenheit. Glass fibrous flexible blanket insulation having density of 0.75 pounds per cubic foot and a K value of 0.30 at 75 degrees mean temperature. Insulation furnished with facing as specified below and indicated in insulation schedule. Insulation and jacket similar to Owens-Corning Type SSL-II.

4. Use pipe and tank fiberglass only when premolded pipe fiberglass is not available. Pipe and tank insulation shall not be used on pipe sizes 24 inches and smaller.

B. Hydrous Calcium Silicate Pipe Insulation

1. Molded, rigid, asbestos free, hydrous calcium silicate water resistant pipe insulation shall be Owens-Corning Fiberglas Kaylo 10 or Manville Thermo-12, molded to dimensional standards conforming to the pipe. Insulation shall have an approximate density of 11 lbs./cu.ft., an approximate thermal conductivity of 0.41 at 200°F mean temperature and shall be suitable for application on surfaces which reach 1200°F. Additional jacket, as hereinafter specified, shall be applied in the field. This material shall be used in finished and concealed areas. In all areas, insulation shall have all joints made with an approved insulation cement to prevent heat leakage through joints. Insulation shall be secured by wire on 9 inch centers.

2. Valves, flanges and fittings occurring in lines insulated with calcium silicate insulation shall be covered with fabricated, mitered segments of

molded calcium silicate of thickness equal to insulation on adjacent pipe, wired in place and made smooth with a thin coat of insulating cement. Fittings on pipes 2 inches and smaller may be insulated with insulating cement to a thickness equal to that of adjacent pipe insulation. All fittings shall be finished with glass fabric embedded in fire retardant adhesive

C. Equipment insulation:

1. Rigid fiberglass: Recommended temperature to 450 degrees F. Fiberglass rigid board having a density of 3.0 pounds per cubic foot and a K value of 0.23 at 75 degrees F mean temperature. See schedule for facing type.

2. Flexible fiberglass: Recommended temperature to 250 degrees F with facing. Glass fibrous flexible blanket insulation having a density of 0.75 pounds per cubic foot and a K value of 0.30 at 75 degrees F mean temperature.

3. Rigid fiberglass high temperature: Recommended temperature to 850 degrees Fahrenheit. Fiberglass high temperature board having a density of 3 pounds per cubic foot and a K value of 0.30 at 200 degrees Fahrenheit mean temperature.

D. Insulation facing:

1. Code ASJ: All service jacket composed of high intensity white chemically treated Kraft paper reinforced with fiberglass yarn and mesh and laminated to aluminum foil with a fire retardant adhesive. Longitudinal laps and butt strips shall be a minimum of 3 inches.

2. Code FSKL: 0.35 mil aluminum foil reinforced with fiberglass yarn reinforcing scrim and laminated to chemically treated fire resistive Kraft paper having a minimum 35 pound per inch width tensile strength when tested in accordance with ASTM D 828. Water vapor permeability 0.04 perms. Longitudinal laps and butt strips shall be a minimum of 3 inches.

E. Additional insulation jacket:

1. ADJ-1: Approximately 6 ounce per square yard glass cloth jacket with thread count of 5 strands per square inch.

2. ADJ-2: Approximately 2 ounce per square yard glass cloth jacket with a thread count of 10 strands by 10 strands per square inch. Jacket shall be used for covering pipe and pipe fittings.

3. ADJ-3a: 0.016 inch thick aluminum jacket conforming to ASTM B-209 with a 1 mil factory applied polykraft moisture barrier. Longitudinal

joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 1 mil polykraft or acrylic vapor barrier.

4. ADJ-3b: 0.020 inch thick aluminum jacket conforming to ASTM B-209 with a 3 mil factory applied polykraft moisture barrier. Longitudinal joints shall be placed at the side of the pipe facing downward at either the 4 o'clock or 8 o'clock position so as to shed water. Aluminum fitting covers, two piece elbows, tees, valve and flange covers, etc., with a 3 mil polykraft or acrylic vapor barrier.

5. ADJ-4: 20 mil PVC jacket suitable for all types of paint. Similar to Manville Zeston 25/50.

6. ADJ-5: shall be a Cell-Co plastic jacket with the following color coded pattern:

a.	Hot Water:	Orange
b.	City Water:	Gray
c.	Boiler Services:	White
d.	Other	Yellow-green

7. ADJ-6 Finish jacket of an Asbestos-free and woven as high temperature, heat-resistant fiberglass fabric. Lagging Cloth having a treated weight of 18.5 oz. Material shall be suitable for a sustained operation at 1100°F. Calcium silicate piping for generator exhaust piping shall also be jacketed with corrugated aluminum.

8. ADJ-7: 0.16-inch thick type T-316 stainless steel jacket. Alloys conforming to ASTM A-240. System shall have a 3-mil polykraft vapor barrier.

F. Adhesives:

1. Code ADH-1: Fibrous adhesive, non-flammable, quick setting adhesive for calcium silicate. Similar to Childers CP-97, 98.

2. Code ADH-2: Fast-drying vinyl base coating and lagging adhesive. Similar to Childers CP-50A HV2.

3. Code ADH-3: Fast-drying neoprene base adhesive for lap joints of foil-faced facing applied over pipe insulation. Similar to Childers CP-82.

4. Code ADH-4: Adhesive for use in adhering fiberglass board or blanket insulation to pipe and equipment. 3M Company Insulation Adhesive No. 35 or 38 non-flammable adhesive.

G. Caulking components:

1. Code CC-1: For use with foam glass and/or joint sealant applications. Flexible elastomeric vapor barrier sealant. Similar to Childers CP-76.

H. Mastics:

1. Code MAS-1: Vapor barrier mastic made with an elastomeric resin. For indoor use. Similar to Childers CP-30.

2. Code MAS-2: A non-water vapor barrier asphaltic emulsion coating, breathing type, for above ground installations. Similar to Childers CP-10.

3. Code MAS-3: Vapor barrier mastic made with an elastomeric resin. For outdoor use.

I. Tie wire:

1. Tie wire for securing insulation in place shall be type 304 stainless steel annealed steel wire of gauge and proper spacing as recommended by the insulation manufacturer. Wire shall be drawn up tightly enough to become embedded in the insulation and the ends of the loop twisted, bent over, and pressed into the insulation so as to leave no ends protruding.

J. Banding:

1. 3/8 inch x 0.02 inch type 304 stainless steel for pipe insulation.

2. 3/4 inch x 0.02 inch type 304 stainless steel for additional insulation jackets.

K. Wire mesh:

1. Wire mesh shall be one inch by No. 20 BGW hexagonal mesh galvanized.

2. Expanded metal: Expanded metal shall be 1/2 inch Hi-Rib metal lath of copper bearing steel.

L. Tape:

1. Lead foil tape shall be 3M Company Lead Foil Tape No. 422, 4 mil thick, acrylic adhesive, 2 inch wide.

2. Vinyl plastic tape, silver gray, flame resistant, vapor barrier sealant tape on rigid and flexible insulation material for warm or cold air ducts. Similar to 3M Company Duct Sealing Tape No. 474.

3. Aluminum foil tape, dead soft aluminum foil, point seal on stick pin, metal patching, moisture barrier, heat reflecting and general sealing on aluminum facing foil. Similar to 3M Company Aluminum Foil Tape No. 425.

M. Staples:

1. Staples shall be galvanized clad outward clinching insulation staples.

N. Insulating cement:

1. Insulating cement shall be a mineral-fiber (wool) ASTM C 195 base material having essentially the same insulating characteristics as the adjacent insulation. Similar to PABCO High Temperature Insulating Cement. Insulating cement shall be applied in layers to a maximum thickness of 1/2 inch at one time. Each layer shall be allowed to dry thoroughly before subsequent layers are applied.

O. Finishing cement:

1. Finishing cement ASTM C 449 shall be diatomaceous silica thermal insulating materials with a suitable proportion of heat resistant binder, hydraulic setting insulating cement capable of withstanding maximum temperature of 700 degrees Fahrenheit. When mixed with water it shall be a plastic mix suitable for trowel applications and shall present a hard, smooth and durable surface after drying. Similar to PABCO No. 127.

P. Combination insulating and finishing cement:

1. Similar to Ryder One Coat or equal.

Q. Welding studs:

1. Welding studs shall be capacitor type split pin or TCP tipped insulation pins with speed clips. Similar to Nelson Stud Welding Spec. 28.

PART 3 – EXECUTION

3.01 PREPARATION

A. No insulation shall be applied until the surfaces of the equipment to be insulated are thoroughly cleaned and until pipes and equipment to be insulated have been leak tested and proven tight and accepted by THE ENGINEER

B. Insulation shall not be applied to piping or equipment until authorization is given to the Contractor by THE ENGINEER. Contractor shall submit a request for authorization. If any insulation is applied without first obtaining authorization, it will be the Contractor's responsibility to remove the insulation and apply it again if so directed.

C. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

D. The execution of the insulation work shall be in strict accordance with the best practices of the trade and with the specifications.

E. The insulation shall be handled and applied in a manner that will not adversely affect its structural or insulating properties.

F. The installation instructions provided by the insulation material manufacturer of all materials specified in this Section shall be followed when installing these materials. Where the specifications are in conflict with manufacturers' instructions, such conflicts shall be brought to the attention of the ENGINEER for a decision.

G. Welding operations will not be permitted on certain specific items of equipment, piping and components for the application of studs, pins, support rings, angles, etc. Contractor shall obtain permission in writing from THE ENGINEER to perform any welding.

H. Coat to seal all insulating cement and calcium silicate surfaces with primer similar to Childers CP-53 or equal before applying any mastic coating.

3.02 PIPING INSULATION INSTALLATION

A. Ensure insulation is continuous through interior walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed. Insulation on all cold surfaces where vapor barrier jackets are specified must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, and other heat conductive parts that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.

B. Insulate fittings, valves, unions, flanges, and strainers. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with PVC or aluminum end caps.

C. Premolded fiberglass insulation for straight pipes shall be applied, neatly fitted around piping and sealed with adhesive ADH-3. Adhesive shall be applied to only one side of each joint and shall not be applied to the pipe surface.

D. Where two sections of pipe insulation butt together provide a 3 inch wide butt strip of same facing material as adjacent insulation facing. Adhere neatly in place using adhesive ADH-3.

E. All pipe elbows shall be insulated with short radial and mitered pieces of board or block insulation or premolded pieces of pipe insulation. Each piece shall be butted tightly against the adjoining piece and all joints, seams, voids and irregular surfaces shall be filled with insulating cement finished to a smooth, hard and uniform contour. Coat with MAS-1 mastic and reinforce with ADJ-2 additional jacket. In addition, place a fitted PVC cover (ADJ-4) over insulated elbow exception. Tape elbow to adjoining insulation.

F. All valves and fittings shall be insulated with premolded fittings, sectional pipe insulation, or blocks of the same material and thickness as used for the adjacent pipe. Flange insulation shall overlap the adjoining pipe insulation by not less than the thickness of the pipe insulation. Sectional pipe covering or block insulation shall be cut to fit, and each section butted closely to the next and held in place with tie wire.

G. Fittings on pipe lines in finished and concealed areas shall be covered with premolded fiberglass pipe fitting insulators Insul-Coustic or equal, where sizes are available, otherwise, use mitercut segments of molded pipe insulation, wire in place with joints and raw edges sealed with adhesive and smoothed out with a coat of insulating cement.

H. On cold pipes the fittings shall be finished with (2) coats of an approved vapor barrier mastic, reinforced with glass cloth extending 2 inches onto adjacent pipe insulation. Hot pipes shall be finished in a similar manner except the mastic need not be of the vapor barrier type.

I. Insulation shall cover the entire surface of the fittings and bodies of the valves up to and including the bonnets, and to the valve stuffing box studs, bolts, or nuts. All joints, seams, and irregular surfaces shall be filled with insulating cement. The insulated surfaces shall be covered with a 1/4 inch thick layer of finishing cement and heavily coated with vapor barrier mastic MAS-1 for cold services and mastic MAS-2 for hot services and reinforced with ADJ-2 additional jacket. Mastic shall be trowelled to a smooth and well-shaped contour compatible with adjoining pipe insulation jackets as specified.

J. Use ADJ-4 covers over fittings and flanges everywhere except when ADJ-3a, ADJ-3b, or ADJ-5 is specified.

K. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship on all joints of all piping.

L. All instrument connections for thermometers, thermocouples, gauges, test connections, flow meters, etc., on insulated pipes, vessels, or equipment shall be insulated. The insulation shall be shaped at these connections by tapering it to and around the connection with insulating cement and finishing with finishing cement, vapor barrier adhesive, applicable mastic, or caulking compound.

M. Where removable flange and valve insulation is required or specified, installation shall conform to the following:

1. Removable flange insulation shall be made from sectional pipe insulation of the same thickness as that on the adjoining pipe or from block insulation 1/2 inch thinner than the pipe insulation and finished with insulating cement. Insulation jackets shall be the same as adjoining pipe insulation unless indicated otherwise.

2. When flange covers are made from sectional pipe insulation, they shall enclose the flanges and be long enough to extend at least 2 inches over the adjacent pipe insulation on each side of the flange. The space between the flange cover and the pipe insulation shall be filled with insulating cement. Secure the flange cover in place with stainless steel banding.

3. When flange covers are made from block insulation, they shall be made in two halves. Each half shall consist of mitered blocks wired to 1/2 inch galvanized hardware cloth mesh. This wire frame, with its attached insulation, shall then be secured to the flanges with tie wire. The insulation cover shall be long enough to extend at least 2 inches over the adjacent pipe insulation on each side of the flange. The space between the flange cover and the pipe insulation shall be filled with insulating cement. The whole flange cover assembly shall be finished with 1/2 inch of insulating cement applied in two coats. After the first coat is dry, the second coat shall be trowelled to a smooth hard finish. All surfaces shall then be finished with jackets as specified in the schedule.

4. Removable valve insulation covers shall be constructed in the same manner as for flanges with the following exception; the two part section shall be divided on the vertical center line of the valve body, bonnet, flange or joint.

5. When specified to insulate the complete valve, the hand wheel or lug wrench shall be removed to accommodate the valve bonnet box. The valve bonnet box shall be constructed in a one piece closure, one end closed, one end opened to fit up to the valve body insulation. Securing the

valve and bonnet box sections, sealing and pointing of the insulation shall be done in same manner as specified for flange covers.

6. Unless indicated as removable, a permanent installation as previously specified shall be used.

7. Protect insulation on piping 2 ½" and up where supported in hangers by means of calcium silicate rigid pipe insulation or jackets. Saddles or shaped galvanized steel pieces approximately 10" long by half the circumferences of insulated pipe.

8. All piping shall have been tested and approved prior to installation of insulation.

9. All piping or surfaces where subject to condensation on the outside shall be insulated including vaporseal finish.

PART 4 – SCHEDULES

4.01 PIPING INSULATION SCHEDULE: (ASJ = "All-Service-Jacket")

Service	Type Insulation and Thickness (Inches)	Facing	Additional Jacket*
Hot Water Heating, Glycol Systems Up to 1 ½" 2" & Up	Molded Fiber Glass 1 ½" 2	 ASJ ASJ	
Cold Water Make-up	Molded Fiber Glass 1 ½"	 ASJ	
All outdoor piping	Two times thickness scheduled except heat traced		ADJ-3b
All pipe within equipment room with boilers plant	As scheduled		ADJ-5
Others not scheduled	Molded Fiber Glass 1 ½"	ASJ	

*Including elbows, fittings, valves, complete system.

A. Refer to jacket specifications for finish covering to be installed on calcium silicate insulation in finished areas.

B. Where "Finishing Cement" finishes are scheduled, refer to specifications for Cement herein for materials, method of application, thickness, etc.

C. Provide vapor barrier on all cold water and rainwater piping.

D. Piping exposed to weather shall be insulated with pipe insulation using double the thicknesses scheduled hereinbefore, up to 24 inches beyond the point where pipes enter the building. Provide weatherproof jacket as hereinafter specified.

E. Equipment drains and floor drains from cooling coils as well as drinking fountain waste shall be insulated 6 feet downstream from connection point.

F. Aluminum jacket required within all tunnels.

END OF SECTION 230719

SECTION 232001 – HVAC PIPING AND JOINTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install piping, fittings, flanges, unions, bolting, gaskets, welding, and threading for all main piping network, branches and connections to all HVAC equipment and systems.

B. All systems shall be installed in accordance with local code including vent piping and relief discharge termination points.

C. Secure and pay for all permits and local/state approvals for the installation of all components included under this Section. Arrange for all inspections.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. ASME: American Society of Mechanical Engineers

C. NFPA: National Fire Protection Association

D. ANSI: American National Standards Institute

1. A13.1: Scheme for Identification of Piping Systems
2. B16.1: Cast Iron Pipe Flanges and Flanged Fittings
3. B16.3: Malleable Iron Threaded Fittings
4. B16.4: Cast Iron Threaded Fittings
5. B16.5: Pipe Flanges and Flanged Fittings
6. B16.9: Factory Made Wrought Steel Butt Weld Fittings
7. B16.15: Cast Bronze Threaded Fittings
8. B16.18: Cast Copper Alloy Solder Joint Pressure Fittings
9. B16.20: Metallic Gaskets for Pipe Flanges
10. B16.21: Now Metallic Flat Gaskets for Pipe Flanges
11. B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
12. B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 800, 1500 and 2500
13. B182.1 Square and hex bolts and screws
14. B182.2 Square and hex nuts
15. B16.39: Malleable Iron Threaded Pipe Unions
16. B16.42: Ductile Iron Pipe Flanges and Flanged Fittings
17. B31.9: Building Service Piping
18. B36.10: Welded and Seamless Wrought Steel Pipe
19. Z49.1: Safety in Welding and Cutting

E. ASTM: American Society for Testing and Materials

1. A 47: Ferritic Malleable Iron Castings
2. A 53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

3. A 74: Cast Iron Soil Pipe and Fittings

4. A 105/A105M: Forgings, Carbon Steel, for Piping Components

5. A 106: Seamless Carbon Steel Pipe for High-Temperature Service

6. A 135: Electric-Resistance-Welded Steel Pipe

7. A 153: Zinc Coating (Hot Dip) on Iron and Steel Hardware

8. A 183: Carbon Steel Track Bolts and Nuts

9. A193: Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

10. A194: Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service

11. A197: Cupola Malleable Iron

12. A 234/A23AM: Pipe Fittings of Wrought Carbon Steel and Alloy / Rev A: Steel for Moderate and Elevated Temperature

13. A 307: Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength

14. A 536: Ductile Iron Castings

15. A 568: Steel, Sheet Carbon and High-Strength Low-Alloy / Rev A: Hot-Rolled and Cold-Rolled, General Requirements

16. A 795: Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

17. B 32: Solder Metal

18. B 43: Seamless Red Brass Pipe, Standard Sizes

19. B 75: Seamless Copper Tube

20. B 88: Seamless Copper Water Tube

21. F 36: Compressibility and Recovery of Gasket Materials

22. F 37: Sealability of Gasket Material

23. F 38: Creep Relaxation of a Gasket Material

24. F 146: Fluid Resistance of Gasket Materials

25. F 104: Non-metallic Gasket Materials

26. F 152: Tension Testing of Nonmetallic Gasket Materials

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 232000 for additional information.

C. Product Data: Include date on pipe materials, steam/condensate specialties, pipe fittings and accessories. Provide manufacturers catalogue information and mill certificates.

D. Welders Certificate: Include welder's certification of compliance with ASME (BPV IX).

E. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

F. Project Record Documents: Record actual locations of all piping, valves, traps and valve tag numbers.

G. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable designation.

H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

I. Provide piping plans to a minimum scale of ¼" - 1'-0".

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer: Company specializing in performing work of the type specified in this section, with documented experience.

C. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

D. Welders: Certify in accordance with ASME (BPV IX).

1.08 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 code for installation of piping systems including specialties.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Protect piping systems and specialties from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.11 ENVIRONMENTAL

A. Do not install piping when environmental conditions are outside the specific limitations of the referenced codes and manufacturer's recommendations.

PART 2 – PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. Provide all piping, fittings, flanges, couplings, unions, bolting, gaskets, welding, threading and soldering for main piping network, branches and connections to

equipment as shown on the drawings and as required to provide complete systems. All piping, fittings and accessories shall conform to the appropriate Service Pipe Schedule as specified hereinafter.

1. Acceptable manufacturers contingent on compliance with the specifications.

    a. Pipe

        1) Steel

            a) U.S. Steel or approved equal.

        2) Copper

            a) Cambridge Lee or approved equal.

    b. Fittings

        1) Welded Fittings

            a) Weld Bend or approved equal.

        2) Cast Iron Fittings

            a) Ward or approved equal.

        3) Grooved Piping

            a) Victaulic of America or approved equal.

B. General

1. All pipe and fitting shall be new, first quality material suitable for continuous operation under the conditions specified. All material shall be in conformance with ANSI Standards.

2. All pipe shall be a product of the United States of America. Mill certificate shall be provided as required.

3. All piping shall be clearly marked with material specification.

4. All pipe and material shall comply with the requirements and recommended practices of ASME B31.9 Building Service Code (latest Edition and Addenda).

5. Elbows shall be long radius ANSI B16.9 unless otherwise specified.

6. Fittings shall be used at all branch connections from headers.

7. Acceptable fittings shall be tees. "Weldolets", and "Threadolets" will also be allowed as specified. Fishmouth or shaped nipples will not be allowed.

8. Provide drains at low points and vents at high points of all piping systems and between pumps and check valves.

9. Lubricants used for the installation of grooved couplings shall be approved by the coupling manufacturer.

10. All pipe and fittings with threaded ends shall have IPS threads cut clean and true and in conformance with the ANSI B1.20.1.

11. Threaded pipe and fittings shall be made up with special care to avoid marring or damaging pipe and fitting surfaces.

12. All threaded joints in steel and iron pipe shall be made up with pipe thread compound or other compound suitable for design temperature and pressure of piping. All threaded joints in copper pipe shall be made up with Teflon pipe tape, petroleum gas grade, wound on male threads, clockwise as viewed from end of pipe.

13. Provide brass, bronze steel or cast ductile iron (as appropriate) dielectric unions or flanges between dissimilar pipe materials to prevent galvanic action, as required. Gaskets shall be suitable for operation up to design temperature of the piping.

14. No joints shall be "backed-off" to align pipe and fittings.

15. Gauge lines shall be stainless steel with compression fittings.

16. Piping for compressed air for controls shall be copper.

17. Use "Never-Freeze" Copper Anti-Seize by Fredericksealor similar on all flange bolts. Torque all bolts to suitable values using torque wrenches.

2.03 SERVICE PIPE SCHEDULE

Service	**Type**	**Grade**	**Wall**		**Joints (Minimum Sch. Shall match Wall)**		**Test Pressure**
			to 10"	**12" & Up**	**2" and Less**	**2½" & Up**	**PSIG**

Service	Type	Grade	Wall		Joints (Minimum Sch. Shall match Wall)		Test Pressure
			to 10"	12" & Up	2" and Less	2½" & Up	PSIG
Hot water supply and return(boiler plant only. See snow melt specifications for platform piping)	A106 or A53 Seamless or ERW	A or B	Sch.40	Standard 0.375"	Threaded	Butt Welded	125
Make-up and fill (up to 150F on grooved)	Hard Drawn Copper	ASTM B88	Type L		95-5 Solder	Silver Brazed or Grooved	125
Miscellaneous atmospheric vents (up to 150F on grooved)	A53	A or B	Sch.40	Standard 0.375"	Threaded Note 2	Butt Welded or Grooved	125 (with air)
Miscellaneous drains 2½" & up (up to 150F on grooved)	A53	A or B	Sch.40	Standard 0.375"		Butt Welded or Grooved	125
Miscellaneous drains to 2"	Hard Drawn Copper	ASTM B88	Type L		DWV 95-5 Solder		125
Refrigerant relief for all other units	Hard Drawn Copper	ASTM B88	Type L		Silver Brazed	Silver Brazed	---
Refrigerant system	Hard Drawn Copper ACR	ASTM B280	Type L		Silver Brazed	Silver Brazed	---
Other piping (up to 150F on grooved)	A106 or A53 Seamless or ERW	A or B	Sch.80	Extra Strong 0.5"	Threaded Malleable	Butt Welded or Grooved	125

Note 1: In concealed inaccessible location provide socket welded.

Note 2: Outdoor portion of piping shall be painted with a high temperature rust inhibiting primer and two coats of high temperature enamel paint (color shall be black unless otherwise selected by the architect).

Note 3: Grooved piping systems of standard wall shall be roll grooved according to Victaulic roll groove specification standards. On piping heavier than standard wall, cut grooving required per Victaulic cut groove specification standard. Gasket must be selected for intended service.

Note 4: Hot water piping, 2" and smaller, may be hard drawn Type L copper tubing with wrought copper fittings and 95-5 non-lead solder at the option of the contractor.

2.04 FITTINGS

A. For Steel Pipe

1. 2 1/2" and Larger, Butt Welded

a. Butt weld, same weight as piping.

b. ANSI A234 WPB

c. ANSI B16.9

d. Branch Connections:

1) Equal to main and to (2) pipe sizes smaller shall be welded tees.

2) Three (3) pipe sizes and smaller than main:

a) 2 1/2" and larger: Weldolets or Tee

b) To 2": Thread-O-Lets, or Tee.

2. 2" and Smaller Screwed

a. Cast Iron: A126 ANSI B16.1, B16.4

1) 125 lb., wsp

2) 250 lb., wsp where noted

b. Malleable Iron: A47, A197, ANSI B16.3

1) 150 lb., wsp. Galvanized for fill and make-up water galvanized piping.

2) 150 lb. wsp.

3) 300 lb. wsp where noted

3. Mechanical Couplings and Fittings: Contractor's option to provide mechanical couplings and fittings in lieu of welded fittings and joints for water service not exceeding 150°F in exposed areas and mechanical rooms or runs above ceiling tile or drop ceiling that provide access.

a. Mechanical Couplings: Ductile iron, ASTM A536, Grade 65-45-12, for following working pressures with standard wall pipe:

Note: With the use of these coupling and fittings, the contractor shall include molded insulation similar to Pro-Tec-T-Kotes, Dallas, Texas.

1) Up To 6" IPS: 700 psi

2) 8" to 12" IPS: 400 psi

3) Rigid Type:

a) Up to 12”: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style 07.

4) Flexible Type Couplings:

a) Up to 12”: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 77.

5) Flange Adapters:

a) Up to 12”: Flat face, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741.

b. Fittings: Grooved type, ductile iron ASTM A536 or malleable iron as specified for couplings to 12". For 12" to 24", steel ASTM A234, rated 300 psi working pressure.

1) Up to 12”: Grooved type, ductile iron ASTM A536 as specified for couplings; steel ASTM A234; or factory fabricated from carbon steel pipe conforming to ASTM A53; rated working pressure equal to adjoining couplings.

c. No mechanical couplings shall be used in inaccessible location such as above plaster ceilings without access doors. Couplings may be used above ceiling tiles or drop ceilings. If access doors are used at each joint in shafts, door shall clearly access joints. The Mechanical Contractor shall furnish doors, coordinate each location, and obtain written approval for each location from the Architect.

d. The following **are not** acceptable:

1) Victaulic Fit products

2) Victaulic Hole cut products

3) Reducing coupling

e. Valves shall meet the valve specification and may be grooved. The Victaulic 300 MasterSeal™ butterfly valve may be used in place of the specified butterfly valves in Victaulic systems for sizes through 12".

f. All strainers shall be Wye or Tee type. Victaulic Style 730 or Style 732 for sizes through 12".

B. For Copper Tubing

1. Solder Joint: Wrought Copper, ANSI B16.22 or Cast Bronze B16.18.

a. 2" and less

1) 95-5 non-lead alloy.

b. 2½" and larger

1) Silver brazing alloy.

a) For refrigerant piping and where noted: Silver brazing alloy, similar to Handy and Harman Easy-Flo.

2. Compression and Flared Fittings: Cast brass, ANSI B16.26.

C. Grooved Joint Couplings and Fittings 2-1/2" and Larger:

1. Couplings shall consist of two ASTM A536 ductile iron housing segments cast with offsetting, angle-pattern bolt pads to provide system rigidity, coated with copper-colored alkyd enamel. Gaskets shall be pressure-responsive, synthetic rubber of a FlushSeal® design, Grade EPDM for hot water systems to 230°F, secured together with plated steel bolts and nuts, ASTM A183 or A449. Couplings shall be manufactured to connect copper tubing sized tube and fittings. Victaulic Style 606.

2. Grooved end fittings shall be wrought copper conforming to ASTM B75 or B152 per ANSI B16.22, or bronze castings conforming to ASTM B584 per ANSI B16.18. Fittings shall be manufactured to copper tubing sizes

with grooves designed to accept Victaulic Style 606 couplings. Flaring of tube and fitting ends to IPS dimensions is not permitted.

D. For Red Brass Pipe: Standard cast bronze, banded, threaded, ANSI B16.15.

2.05 FLANGES

A. For Steel Pipe

1. Welded: Weld neck, ANSI B16.5.

a. 150 lb. Wsp
b. 300 lb. Wsp
c. 400 lb. Wsp

2. Match connecting flange class and facing.

3. Grooved Joint Flange Adapters

a. Ductile iron, flat face, for direct connection to ANSI Class 125 and 150 flanges. Victaulic Style 741.

b. Ductile iron, flat face for direct connection to ANSI Class 300 flanges. Victaulic Style 743.

2.06 FLANGE GASKETS

A. One-piece ring type 1/16" thick, except as noted.

B. Suitable for temperature, pressure and service of system.

C. Compressed compound fiber type for the following:

1. Hot water.

2. Cold water.

D. For Joints of Dissimilar Metals

1. Isolating gaskets, sleeves, and washers between flanges, bolts and nuts.

2. Gaskets, similar to DuPont Teflon.

2.07 UNIONS

A. For Steel Pipe

1. Malleable iron 300 lb. Wsp

    a. Ground Jacket Seat: Brass-to-iron, black or galvanized to match piping.

2. Forged steel, 2000, 3000 lb. WOG class, bronze-to-steel or steel-to-steel seats, where noted or required for service.

3. Unions are not required on installations using grooved connections. The couplings shall serve as unions.

B. For Red Brass Pipe

1. All bronze, 150 lb. wsp, ground joint seat.

PART 3 – INSTALLATION

3.01 PIPING INSTALLATION

A. Provide all piping systems as shown on the drawings and otherwise required to make a complete, workable and neat job, installing all valves, appurtenances, grooved joint couplings, unions and gaskets. The Contractor shall use care arranging all piping as shown on the drawings and shall carefully examine the arrangements where offsets are indicated and shall follow details as shown.

B. All piping shall be run to true alignment generally parallel or perpendicular to adjacent building walls, floors and ceilings and with uniform grades and spacing so as to present a neat and workmanlike appearance.

C. Care shall be paid to the exact locations for all piping and equipment with respect to equipment, ducts, conduits, slabs, beams and lighting fixtures, so as to provide maximum access to all mechanical and electrical equipment in the buildings. Close coordination and cooperation shall be exercised with other Trades in locating the piping and equipment in the best interests of the Owner. The drawings and specifications covering other work to be done in the buildings shall be carefully studied and arrangements made to avoid conflict.

D. The drawings shall be followed where they are definite and provided such procedure causes no objectionable conditions or does not conflict with other Trades, Laws, Regulations or recommendations of equipment manufacturers. The drawings are intended to indicate the sizes of piping connections and if certain sizes are omitted, or unclear, obtain additional information before proceeding.

E. Rough in for all equipment requiring connections to the Mechanical work. Obtain all necessary data on exact locations, sizes, connections, fittings and arrangements and exact routings as may be required for proper installation.

F. Bushings shall not be used for reducers. Reducing fittings shall be used for all changes in pipe size and shall be as follows:

1. Horizontal water piping: Eccentric flat on top for venting.

2. Vertical water: Concentric.

G. Unions, grooved joint couplings or flanges shall be provided in conjunction with all equipment, coils, control valves and specialties in all pipe lines and at all points necessary to provide reasonable access to the piping systems.

H. Ends of all pipes shall be reamed clean and all pipes shall be straightened before erection and measures shall be taken to preserve this cleanliness after erection.

I. Support piping independently at all equipment so that the equipment is not stressed by piping weight or expansion.

J. Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy access and operation.

K. Provide dielectric unions, waterway fittings or flanges between dissimilar pipe materials to prevent galvanic action as required.

L. Provide proper provision for expansion and contraction in all portions of pipe work, to prevent undue strains on piping or apparatus connected. Provide double swings at riser transfers and other offsets to take up expansion. Arrange riser branches to take up motion of riser. Branch runouts to equipment shall have a minimum of (3) elbows, adequately spaced.

M. All piping connections to equipment shall be made with offsets. Provide with unions, grooved joint couplings and/or flanges so arranged that the equipment can be serviced or removed without dismantling the piping. If equipment, when commissioned, becomes air bound or stratified, all necessary modifications to the piping system required to rectify the condition permanently shall be made to piping and equipment, furring, floors, walls, etc., at the Contractor's expense.

N. Pipe pitch, unless otherwise indicated on the drawings, shall be as follows:

1. Water Piping:

a. Up to 1" pipe: 1" in 40'-0", up in direction of flow.
b. 1 1/4" larger: 1" in 100'-0", up in direction of flow.

2. Condensation Drainage:

a. Preferred: 1/4 in./ft., down in direction of flow.
b. Minimum: 1/8 in./ft., down in direction of flow.

O. Drain connections at low points in water piping and where noted:

1. In equipment rooms:

a. To 3" pipe: 3/4" ball valve.
b. 4" to 8": 1 1/2" ball valve.
c. 10" and larger: 2 1/2" ball valve.

2. Other areas:

a. 1/2" ball valve with capped hose connection.

P. Automatic air vents at high points and where required to expel air:

1. Rated for a maximum operating temperature of 240°F at 150 psig. Nell & Gossett No. B7, Taco 418 Hy-Vent or Amtrol 706. Provide a ball valve on the system side of the air vent. Provide a copper drain line down to 6” above mechanical room floors. Vents installed above ceilings shall be piped to the nearest utility sink or floor drain.

Q. Copper tubing and galvanized steel shall not be mixed in any one run of piping, except as otherwise specified herein.

R. During construction, temporarily close open ends of pipes with sheet metal caps or duct tape to prevent debris from entering piping systems.

S. Joints in piping systems, for all services, shall be made tight and leakproof against test pressures. Leaks in screwed or flanged joints which cannot be eliminated by normal wrench tightening methods shall be repaired at the joint. Under no circumstances shall caulking be allowed. No joints shall be backed off to align pipe fittings.

T. Grooved joints shall be installed in accordance with the manufacturer’s latest installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer’s factory trained representative shall provide on-site training for contractor’s field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer’s representative shall

periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

U. Provide extra heavy pipe for nipples where unthreaded portion of pipe is less than 1 1/2" long. Use of close nipples is not permitted.

V. Refrigerant Piping and Connections

1. Provide all refrigeration piping, including thermal expansion valves, driers, moisture indicator sight glasses, shutoff valves, controls, gauges, insulation and other appurtenances, as required to complete the refrigeration system. Piping connections to the units shall be fitted with flexible pipe fittings and renewable unions.

2. The HVAC Contractor shall triple evacuate and field charge entire refrigeration system. All labor and materials required for evacuation, charging, as well as commissioning of the refrigerant systems, shall be provided by the HVAC Contractor. The refrigerant piping arrangement shall be in strict accordance with manufacturer's recommendations. Provide shop drawings indicating sizes and all required components and accessories for Architect's review prior to ordering equipment or installation.

3. All refrigerant piping exposed to weather outside the building shall be properly supported in a manner to allow expansion and contraction. All sleepers provided shall be secured and their installation shall be as directed and approved by the Architect.

4. Refrigerant piping joints shall be made with cadmium free 45% silver brazing filler metal having a melting point of 1225°F. Joint flux, if used, shall be compatible with materials. The outside surface at end of pipe and inside surface of fittings shall be thoroughly cleaned with steel wool or emery cloth, and cut pipe ends shall be reamed and all burrs shall be removed. Care shall be taken to ensure the entry of foreign particles into the system does not occur. While brazing, purge piping with low pressure nitrogen to prevent interior oxidation and to dry the system. Caution must be taken to continuously ventilate the work area and to avoid allowing nitrogen to concentrate in an enclosed area thereby expelling all of the oxygen and causing asphyxiation.

5. Traps shall be factory fabricated one-piece fittings or field assembled 45°-90°-45° elbows. Do not use 90°-90°-90° elbows.

3.02 WELDING

A. All welding done under this Contract shall be performed by experienced welders in a neat and workmanlike manner. All welding done shall be in accordance with ASME B31.9 Building Service Piping Code (latest Edition and Addenda). The Contractor shall furnish to the Owner for approval and record the following:

1. Welding Procedure Specifications (WPS) for each procedure to be used

2. Procedure Qualification Record (PQR)

3. Welding Operator Qualification Tests (WPQ) for each welder to be employed.

B. Documents shall be on forms similar to the forms referenced in the ASME Boiler & Pressure Vessel Code, Section IX, latest edition. These records shall be furnished to the Owner for this project not less than (2) weeks, prior to any welding. All welders to be employed by the Contractor on this work shall be certified in accordance with the above. The Mechanical Contractor shall test welders to these procedures within (3) months of the work beginning to certify them for this work. The above forms shall be clearly marked specifically for the Contractor's use and certified by the appropriate personnel. Documents prepared for other's use are not allowed. Failure to provide these forms to the satisfaction of the Owner, or his representative, will result in the replacement of the Mechanical Contractor with one who can meet these requirements, at no additional cost to the Owner. No delays or cost increases to the overall project schedule will be accepted due to non-compliance with the above by the Mechanical Contractor.

C. Mitered elbows are not permitted. Odd angle elbows shall be cut from long radius elbows.

D. The weld reinforcement shall be not less than 1/16" nor more than 1/8" above the normal surface of the joined sections. The reinforcement shall be crowned at the center and shall taper on each side to the surface being joined. The exposed surface of the weld shall present a workmanlike appearance and shall be free of depressions below the surface of the joined members.

E. No welding of any kind shall be done when the temperature of the base metal is lower than 50°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Temperature of metal shall be "warm to the hand", or approximately 60°F.

F. Welds will be inspected visually by supervisory representatives of the Architect and the Contractor. Any weld judged defective by the Architect from a visual inspection shall be cut out and tested in the presence of the Owner or his representative. In the event any welder consistently produces a high percentage of unsatisfactory production welds, he shall be discharged at the request of the

Owner, even though he is able to produce satisfactory welds when especially tested. Removal and replacement of test coupons and samplings shall be done at the expense of the Contractor. The Owner reserves the right to ultrasonically or radiographically test any welds for full penetration.

G. Paint all external surfaces of welds with a high temperature paint prior to insulation being applied.

H. Store all 7018 electrodes in rod oven once original container is opened.

I. Welds in all high pressure steam and high temperature hot water (350°F or greater) shall be X-ray tested. This X-ray shall be performed by an independent testing company. Testing company shall employ certified weld inspectors. The welds shall meet the X-ray requirements in ANSI B31.1. The independent inspection services shall be provided by the Mechanical Contractor.

J. Provide fire watches required by state and local authorities and fire departments.

3.03 CLEANING AND BLOWING OUT

A. The equipment and piping installed under this Section shall be blown out under pressure and cleaned of foreign matter, through temporary connections where necessary, before the system is placed in service. Precautions shall be used to prevent foreign matter from getting into equipment and piping during construction. The supplier of water treatment equipment and chemicals shall recommend and furnish chemicals for the purpose of cleaning and blowing out of all systems. All chemicals, materials, instruments and labor shall be provided by the Contractor.

B. The surfaces of all equipment and piping shall be clean upon completion of the work.

C. All pipe line strainers shall be cleaned immediately before being turned over to the Owner for acceptance.

D. During cleaning process, hammer welds to remove scale, weld slag and other debris.

3.04 TESTING

A. Furnish all labor, material, instruments, supplies and services and bear all costs for the accomplishment of the tests herein specified. Correct all defects appearing under test and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

B. Perform all tests other than herein specified which may be required by Legal Authorities or by Agencies to whose requirements this work is to conform.

C. Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no additional cost to the Owner.

D. All equipment and piping installed under this Contract shall be tested and found tight. Insulated or otherwise concealed piping shall be tested before being closed in. All leaking joints shall be corrected, retested and found tight. Such tests shall conform to the requirements of Local Codes but shall not be less than the equivalent of the tests called for herein. Threaded joints that leak shall not be seal-welded to correct leakage.

E. Tests performed shall not relieve the Contractor of his responsibility for leaks which may develop after the tests are made.

F. All piping systems shall be subjected to a hydrostatic test at the scheduled test pressure for a period of (4) hours without drop in pressure.

G. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.

H. Systems found to have leaks shall be subjected to further tests when faulty joints have been repaired or replaced.

I. Welded joints shall be subjected to a hammer test while under pressure.

J. Chilled water, condenser water and hot water piping shall be hydrostatically tested to the test pressures scheduled. Equipment and devices which would be damaged at the test pressure, shall be removed or blanked off during testing.

END OF SECTION 232001

SECTION 232123 – HVAC HYDRONIC PUMPS AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all pumps for all systems which are part of the building HVAC systems. This shall include all accessories specified in this Division and as shown on the drawings.

B. All pumps shall be new and manufactured for the specific purpose of circulating chemically treated water to the building HVAC systems.

C. All pumps, circulators and system components shall be installed in accordance with state and local codes.

D. Secure all permits and local/state approval for the components as specified and included under this Section.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NEMA MG1 – Motors and Generators; National Electrical Manufacturers Association.

2. NEMA OS1 – Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports; National Electrical Manufacturers Association; 1989.

3. NFPA 70 – National Electrical Code.

4. UL 778 – Standard for Motor-Operated Water Pumps.

5. ASME – Section VIII, Unfired Pressure Vessels.

C. Reference Standards

1. AFBMA: Anti-Friction Bearing Manufacturers Association.

a. 1-84 - Terminology for Anti-Friction Ball and Roller Bearings and Parts.

b. 9-84 - Load Ratings and Fatigue Life for Ball Bearings.

c. 11-78 -Load Ratings and Fatigue Life for Roller Bearings.

d. 20-77 -Metric Ball and Roller Bearings Conforming to Basic Boundary Plans.

2. ASTM: American Society for Testing and Materials.

a. A 48-Gray Iron Castings.

b. B 62-Standard Specification for Composition Bronze or Ounce Metal Castings.

c. B 584-Standard Specification for Copper Alloy Sand Castings for General Applications.

3. HI: Hydraulics Institute.

a. Hydraulic Institute Standards.

4. ANSI B15.1

5. OSHA: Occupational Safety and Health Administration, U.S. Department of Labor.

1.05 SYSTEM DESCRIPTION

A. Provide base mounted, horizontal axial split-case, or vertical mounted split-case, double-suction, single-stage centrifugal pumps, or base mounted, single-stage end suction radial pumps, as shown on the drawings. Capacity, RPM, head and electrical motor characteristics shall be as scheduled on the drawings.

1.06 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional information.

C. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics, connection requirements and all dimensional data including operating weights.

D. Manufacturer's Installation Instructions: Indicate hanging and/or support requirements and recommendations.

E. Millwright's Certificate: Certify that base mounted pumps have been aligned.

F. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions and replacement parts list.

G. In addition to items specified elsewhere provide:

1. Large scale certified pump curves indicating operating points.

2. Detailed motor data.

3. Detailed coupling data

4. Detailed seal data.

5. All pump construction data.

6. Detailed bearing data.

7. Base details

8. Dimensioned pump and motor drawing.

1.07 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.08 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer Qualifications: Company specializing in manufacturing, assembly and field performance of pumps, with minimum three (3) years of documented experience.

C. Alignment: Base mounted pumps shall be aligned by qualified millwright.

1.09 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by UL 778 testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

B. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.10 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. All pumps shall be delivered in containers and shall be kept in a dry and protected area.

C. All pumps shall be given 2 coats of rust resistant paint at the factory prior to installation.

1.11 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.12 ENVIRONMENTAL

A. Do not paint or install pumps when environmental conditions are outside the specific limitations of the referenced codes and manufacturer’s recommendations.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 MANUFACTURERS ACCEPTABLE FOR PRODUCT TYPES INDICATED CONTINGENT UPON PRODUCTS' COMPLIANCE WITH THE SPECIFICATIONS

A. Base mounted pumps:

1. Bell and Gossett or approved equal.

B. In-line circulators:

1. Bell and Gossett or approved equal.

C. Expansion Tanks

1. Amtrol or approved equal.

D. Air Separators

1. Amtrol or approved equal.

2.03 PUMPS GENERAL

A. Statically and dynamically balance rotating parts.

B. Construction shall permit complete servicing without breaking pipe or motor connections.

C. Pumps to operate at 1750 rpm unless scheduled or specified otherwise.

D. Pumps of the same type shall be from one pump manufacturer.

E. Motors shall be in accordance with Section Motors, unless otherwise specified.

F. Provide guards around shafts and couplings in accordance with OSHA and ANSI recommendations.

G. All parts shall be suitable for Variable frequency drives; including but not limited to Motor, Pump, all pump components, coupling, and base.

H. Design and performance requirements:

1. Scheduled design flow, design head, pump efficiency, and motor horsepower are minimum acceptable.

2. Scheduled design brake horsepower and speed are maximum acceptable.

3. Pump curve shall rise continuously from maximum flow to cut off.

4. Shut-off head shall be approximately 20 percent greater than design head, unless otherwise indicated in pump schedules.

5. Pump brake horsepower not to exceed motor horsepower rating over entire operating range (from shut-off to run-out). Motor shall not operate in service factor

6. Suitable for parallel operation.

7. Pumps shall operate within the preferred operation region as defined by the Hydraulics Institute.

8. Select pump for operation at or near peak efficiency.

9. Cavitation-free at all points on curve.

10. Impeller diameter shall not exceed 90 percent of the maximum cutwater diameter.

11. Vibration levels of pump shall be within the vibration limits established by hydraulic institute.

12. All pump shafts (which are connected to a variable speed drive) must be furnished with a factory mounted shaft grounding brush/device.

2.04 BASE MOUNTED PUMPS

A. Type: Centrifugal, single or multi-stage where noted, base mounted flexible coupled, single or double suction as noted.

1. Casing:

a. Casing shall be constructed of cast iron ASTM A 48 Class 30A or better.

b. Casing shall be rated for 1.25 times the scheduled working pressure with a minimum rating of 150 psig.

c. Cast iron castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters and other defects.

d. Casing shall have flanged suction and discharge per ANSI B16.1 for sizes 2-1/2 inch and larger. Smaller sizes shall be threaded connections.

e. Casing shall have a tapped and threaded plug for an air vent.

f. Casing shall be provided with a threaded drain plug at the lowest point.

g. Casing shall be provided with a seal flush connection.

h. Casing wearing rings shall be replaceable and constructed of bronze ASTM B 584 or ASTM B 62.

i. Casing shall be base supported.

j. Casing shall be vertically or horizontally split as indicated.

2. Impeller:

a. Impeller shall be constructed of one piece bronze ASTM B 584 or ASTM B 62.

b. Fully enclosed design.

c. Impeller shall be keyed to the shaft and secured with a stainless steel, 300 series washer and bolt. Bolt to tighten in direction opposite rotation of impeller.

d. Dynamically balanced for smooth, low vibration operation over the operating range from shut-off to run out.

e. Impeller shall be provided with replaceable wear rings.

3. Shaft:

a. Shaft shall be solid stainless steel AISI 316 turned, ground and polished and ring gauged for accuracy.

b. Shafts shall be polished to a minimum 16 microinch finish.

c. Shaft deflection shall not exceed 0.002 inches in the round.

4. Shaft sleeve:

a. Design such that there is no contact between the pump shaft and the pumped liquid.

b. Shaft sleeve shall be stainless steel, AISI 316 or AISI 416.

c. Provide O-ring or gasket to prevent leakage of pumped liquid.

5. Shaft seals:

a. Mechanical type.

1) Stainless steel hardware and spring.

2) EPT rings, carbon rotating face against a tungsten carbide nickel binder seat.

3) Seals shall be balanced type for all pumps with 100 psig or greater suction pressure.

4) API 610 seal number: USTFM. Similar to John Crane Type 1 or 2 material code **$0_{(28)}$-$P_{(66)}$-1- $0_{(15)}$-1**.

5) Provide a bypass line from the discharge side of the pump casing to the seal faces. Design to ensure adequate flushing and proper lubrication.

b. Provide Doxie or equal cyclone separator on seal flushing lines on all pumps with a head of 25 PSIG or greater.

6. Bearings:

a. Grease lubricated ball bearings.

b. L-10 life minimum 100,000 hours.

7. Motor:

a. Refer to Section 230513 – Motors and Controllers for requirements.

8. Drive coupling:

a. Flexible coupling with OSHA and ANSI type coupling guard.

b. Suitable for variable speed drive.

c. Suitable for system duty, fluid, and service temperature.

9. Similar to T.B. Woods (the coupling service factor shall not be less then 2).

   a. Base:

      1) Cast iron or fabricated steel base with drip rim and tapped NPT connection for drain.

      2) Common base for pump and motor.

10. Painting:

   a. Pump components shall be thoroughly degreased, deburred and sandblasted as required before the application of any primers or paint.

   b. Prime coat components before assembly; finish coat after assembly.

11. Nameplate:

   a. Provide pump with a nameplate constructed of 18-8 stainless steel securely fastened to pump casing by stainless steel pins.

   b. Locate nameplate for easy visibility.

12. The rating conditions and other data below, as a minimum, shall be clearly stamped on the nameplate.

   a. Manufacturer, address, telephone number.

   b. Pump model number.

   c. Pump serial number.

   d. Size (including impeller diameter scheduled in inches).

   e. Type.

   f. Equipment designation as listed on the pump schedule.

   g. Flow scheduled (gallons per minute).

   h. Dynamic head scheduled (feet of water).

i. Efficiency (percent).

j. Shut-off head (feet of water).

k. Speed (RPM).

2.05 IN-LINE CIRCULATOR

A. Casing: Bronze cast iron rated for 125 psi working pressure.

B. Impeller: Bronze.

C. Shaft: Hardened alloy steel with integral thrust collar and oil lubricated bronze sleeve bearings.

D. Seal: Carbon rotating against a stationary ceramic seat.

E. Provide additional pipe supports to support weight of pump, motor, fittings and accessories.

2.06 EXPANSION AND COMPRESSIONS TANKS

A. Provide expansion and compression tanks, air separator and other pump hydronic accessories, as shown and as scheduled on the drawings.

B. Tanks shall be the pressurized captive air bladder type.

C. Provide replaceable elastomeric bladder suitable for a maximum operating temperature of 240°F

D. Provide integral steel base ring for vertical mounting.

E. Tanks shall be constructed and certified to ASME Section VIII

1. Pressure rating150 psig

2. Temperature of 240°F

F. Provided with charging valve enclosure, remote air connector coupling, system connection and lifting rings.

G. Tanks shall be provided with factory applied rustproof coat of paint to the exterior of tanks.

2.07 AIR SEPARATORS

A. Provide air separator with flanged inlet and outlet connections.

1. Provided with drain connection with valve.

2. Shall be tangential type.

3. Bottom blow down.

4. Full size removable strainer.

B. Pressure drop shaft be 1 foot of water and maximum velocity shall be 4 fps.

2.08 MAKEUP AND RELIEF VALVES

A. See specification SECTION 230519.20

PART 3 – EXECUTION

3.01 PUMP INSTALLATION

A. Pumps shall be installed so as to ensure easy accessibility for service or removal and replacement of all components such as, but not limited to, impellers, motors, drive couplings, bearings, strainers, other pump appurtenances and isolators.

B. The Contractor shall receive and inspect all pumps and motors to ensure they are received without defect.

C. All defective or damaged pumps shall be returned to the manufacturer by the Contractor for replacement.

D. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc. Protection shall include temporary plastic wrap to keep equipment in original factory condition.

E. Set pump on concrete base, anchor, level and grout according to manufacturer's instructions. Where specified or where indicated in the equipment schedule on the mechanical drawings provide vibration isolators under pump base.

F. Provide line sized shutoff valve and strainer on suction and line sized silent check valve and flow control balancing valve on discharge unless otherwise noted on mechanical drawings.

G. Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide

supports under elbows on pump suction and discharge line sizes 4 inches and over.

H. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

I. Refer to pump detail on mechanical drawings for other accessories to be provided.

J. Provide drains for bases and stuffing boxes piped to and discharging over floor drain. Provide air cock and drain connection on horizontal pump casings.

K. Manufacturer representative shall check, laser align, and certify base mounted pumps 25 motor horsepower and over, before start-up. Pump and drive shall be aligned in accordance with Hydraulic Institute Standards.

L. Pumps shall be installed so as to ensure easy accessibility for service or removal and replacement of all components such as, but not limited to, impellers, motors, drive couplings, bearings, strainers, other pump appurtenances, isolators, and flex connections.

M. The Contractor shall receive and inspect all pumps and motors to ensure they are received without defect. All defective or damaged pumps shall be replaced.

N. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc.

3.02 EXPANSION TANK

A. Provide where indicated in the drawings.

B. Install in accordance with manufacturer’s installation instructions.

C. Change with air to the specified pressure prior to the system fill.

3.03 AIR SEPARATOR

A. Provide where indicated on the drawings.

B. Install in accordance with manufacturer’s instructions.

END OF SECTION 232123

SECTION 232500 – CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all equipment, controls, chemicals, labor and accessories to make a complete system for chemically treating the HVAC hydronic systems specified herein.

B. All chemicals shall be environmentally safe and compatible.

C. The Mechanical Contractor shall engage the services of a nationally recognized water treatment manufacturer with local representative of such manufacturer to provide a complete water treatment service, designed to minimize corrosion and scale formation in all water systems. This service shall include providing the equipment, controls, chemical feed pumps, shot feeders, all chemicals and consulting analysis service for the initial start-up of each system.

D. The Mechanical Contractor shall provide complete electrical control interlocking wiring for all chemical feeding and control equipment, for a complete system. All electrically driven equipment, such as pumps, shall be provided with starters and disconnect switches under this Contract.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. EPA Regulation.

B. FDA Requirements.

C. ASTM: American Society for Testing and Materials.

1. D596-83 - Standard methods of reporting results of analysis of water.

D. NEMA: National Electric Manufacturers Association.

E. NFPA: National Fire Protection Association.

F. UL: Underwriters Laboratory Inc.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. Shall be in accordance with all other specified requirements as well as those following.

D. Product Data: Submit manufacturer's technical product data, indicating chemical treatment materials, chemicals and equipment. This shall include MSDS and technical data sheets as well as all EPA, FDA, and or other environmental approvals.

E. Shop Drawings: Submit the initial manufacturer of all components and drawings indicating system schematics, equipment locations, and control schematics. In addition a clear concise written sequence of operation shall be provided.

F. Water analysis.

G. A complete scale drawing of the equipment installation

H. Submit manufacturer's installation instructions.

I. Submit reports indicating pre-cleaning completed and submit analysis of system water after cleaning and after treatment.

J. Submit reports indicating start-up of system is completed and is operating properly.

K. Submit an Operations Manual providing equipment manuals, product MSDS and technical data sheets, treatment log sheets, testing program, and description of operating parameters.

L. Product Data: Provide chemical treatment materials, chemicals and equipment including electrical characteristics and connection requirements.

M. Shop Drawings: Indicate system schematic, equipment locations, control schematics, electrical characteristics and connection requirements.

N. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration and connection requirements.

O. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

P. Certificate: Submit certificate of compliance for authority have jurisdiction indicating approval of chemicals and their proposed disposal.

Q. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

R. Operations and Maintenance Data: Include data on chemical feed pumps, agitators and other equipment including spare parts lists, procedures and treatment programs. Include step-by-step instructions on test procedures including target concentrations.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. The water treatment company shall have at least (5) years experience in the treating and servicing of systems as outlined above. All service must be supervised by a chemist or a chemical engineer. The water treatment company shall have full time service located within the trading area of the job site. Manufacturers shall be insured for not less than $10,000,000.

C. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum five (5) years of documented experience and approved by manufacturer.

1.08 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.

B. Products Requiring Electrical Connection: Listed and classified by UL testing firm and acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 MAINTENANCE SERVICE

A. Service Period: Provide chemicals and service program for a period of one (1) year from start-up date of condensing equipment, including the following:

1. Initial water analysis of water supply and recommendations.

2. Systems start-up assistance.

3. Training of operating personnel.

4. Periodic field service and consultation.

5. Customer reports and log sheets.

6. Laboratory technical assistance.

B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements and corrective actions needed. Submit two copies of field service report after each visit.

C. Provide laboratory and technical assistance services during this maintenance period.

D. Include two (2) hour training course for operating personnel, instructing them on installation, care, maintenance, testing and operation of water treatment systems. Arrange course at start up of systems.

E. Provide on site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program and make recommendations in writing based upon these inspections.

1.10 MAINTENANCE MATERIALS

A. Supply sufficient chemicals for treatment and testing during warranty period.

1.11 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.12 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. Acceptable manufacturers contingent upon compliance with the specifications.

1. Neptune or approved equal.

B. Description of Work

1. The HVAC Contractor shall engage the services of a nationally recognized water treatment manufacturer or local representative of such manufacturer to provide a complete water treatment service, designed to minimize corrosion and scale formation in all water systems. This service shall include providing the equipment, controls, chemical feed pumps, bypass feeders, all chemicals and consulting analysis service for the initial clean out and start-up period of each system.

2. Service Period: Provide chemicals and service program for period of (1) year from start-up date of condensing equipment, including the following:

a. Initial water analysis of water supply and recommendations.

b. Systems start-up assistance.

c. Training of operating personnel.

d. Periodic field service and consultation.

e. Customer reports and log sheets.

f. Laboratory technical assistance.

3. Refer to Division 26 for the following work:

a. Power supply wiring from power source to power connection on water treatment equipment. Include starters, disconnects, and required electrical devices, except as specified as furnished, or factory installed, by manufacturer.

b. Interlock wiring between electrically operated equipment units; and between equipment and field installed control devices.

1) Interlock wiring specified as factory installed is work of this section.

4. Provide the following electrical work as work of this section, complying with requirements of Division 26.

a. Control wiring between field installed controls, indicating devices, and unit control panels.

C. Quality Assurance

1. The water treatment company shall have at least (5) years experience in the treating and servicing of systems as outlined above. All service must be supervised by a chemist or a chemical engineer. The water treatment company shall have full time service located within the trading area of the job site. Manufacturers shall be insured for not less than $10,000,000.

2. Codes and Standards

a. UL and NEMA Compliance: Provide electrical components required as part of condenser water treatment equipment, which are UL listed and labeled and comply with NEMA standards..

b. NEC Compliance: Comply with National Electrical Code as applicable to installation, electrical connections, and ancillary electrical components of condenser water treatment equipment.

c. Chemical Standards: Provide only chemical products which are acceptable under state and local pollution control regulations.

d. Provide any and all necessary safety and government approval literature on recommended products and assure compliance with federal, state and local regulations.

2.03 PRE-CLEANING

A. The HVAC Contractor shall closely coordinate with the water treatment company to insure that each piping system is properly cleaned prior to placing in use and

that no system is filled with water without proper water treatment chemicals being added.

1. Pre-cleaning chemical shall be TSP based and shall contain a flash rusting protection package. Disposal shall be to an approved waste treatment system.

2. Procedures

    a. Flush all systems and then install precleaning chemicals to remove construction deposits such as pipe dope, oils, loose mill scale, and other extraneous materials.

    b. Add recommended dosages and circulate for 6 to 8 hours.

    c. Drain and flush until total alkalinity of rinse water is equal to make-up water.

    d. Remove, clean, and replace strainer screens.

    e. Refill with clean water to start treatment procedures.

2.04 PROPYLENE GLYCOL SYSTEMS

A. Provide complete initial fill of 40% propylene glycol/60% water for all glycol systems. Propylene glycol solution shall be Dowfrost as manufactured by Dow Chemical Co. or Union Carbide. Top off, test and adjust system solution after all piping systems have been tested and received. Refer to details on the drawings for automatic glycol fill system schematic.

B. Provide model G-50-1A, Neptune package glycol feed system with integral pump, low level light and audible alarm.

C. Tank shall be 50 gallon H.D., self-supporting natural polyethylene having vertical embossed graduations, stainless steel cover divided at midpoint with full diameter stainless steel piano hinge and drilled for pump mounting, suction line, fresh water fill, agitator and liquid level monitor. Tank shall be CCS, CB50 or equal.

D. Chemical injection pump shall be 110 volt, minimum 1/3 HP drive, 3/8" positive displacement, to be used for charging of glycol and future additional inhibitor. Pump is to have a bronze housing with stainless or bronze liquid drivers and internal, discharge pressure gauge, and adjustable internal relief valve set so as not to exceed normal system operating pressures. Output is to be at least 5.0 gallons per minute at 100 psi. The pump discharge line is to be fitted with a ball or swing check valve to prevent system backflow (zero flow leakage) when valves are open to main headers. Unless otherwise specified, pump operation shall be initiated by a switch controlled 110 volt circuit. Pumps shall be CCS

P283A series. Provide an electric transfer pump system to transfer concentrated propylene glycol to the moving tank. Provide a pre-pressurized diaphragm tank, pressure tank at least 15 gallons in size to maintain pressure on the main fluid system.

E. Accessory Switch: Provide adjustable pressure switch to prevent operation of glycol chemical pump above system PRV settings, as manufactured by Mercoid DA-31, United or approved equal.

PART 3 - EXECUTION

3.01 EQUIPMENT START-UP, FOLLOW-UP AND TRAINING

A. The Water Treatment Contractor shall provide:

1. Recommendations in writing for all chemical types to be used in each system depending on local water quality and suitability. Chemicals shall be listed in generic terms.

2. Recommendation in writing on procedures, logs book entry and correct chemical applications.

3. Complete training of maintenance and operating personnel.

4. Start-up consisting of at least (3) days with weekly visits for the first month of operation.

5. After start-up, monthly visits at least every (30) days for a period of (1) year to analyze all water systems. Each analysis to be submitted in writing containing all results and recommendations to the Owner for corrective action.

6. A microbiological dip slide culture kit shall be provided and testing, including incubation, shall be performed.

7. Monthly Service

a. Provide weekly service checks during initial start-up month and bi-weekly service during the 2nd month.

b. Run control tests and submit a written service report covering all aspects of chemical treatment.

c. Recommended changes in chemical feed rate or blowdown/bleed schedule as indicated by control tests.

3.02 OTHER SERVICE

A. Provide in-service training of operating engineers on product testing and chemical performance.

1. Operator Training: Train operating personnel in use, operation, and maintenance of all water treatment systems.

2. A program administration manual shall be furnished encompassing all systems covered in this Section.

3. Three days of training for operating personnel shall be priced including all expenses. Document in bid tabulation form.

B. Inspect boiler and condenser water surfaces at their regular inspection intervals.

C. Provide all laboratory reports on corrosion or deposit analysis as needed.

D. Make available all test kits and testing reagents to assure accurate test results.

E. Provide all log books for all equipment rooms so test results may be recorded. Log Books should contain:

1. Product technical data sheets

2. Product Material Safety Data Sheets

3. Equipment Literature

4. Program Operating & Testing Parameters

5. Chemical Testing and Blowdown/Bleed Log Sheets

F. System Testing and Follow Up

1. Chemical treatment representative shall visit the site once every month during the guarantee period. The representative shall check and adjust water treatment system operation during each visit, check efficiency of chemicals and chemical applications, and instruct and advise operating personnel.

2. At each inspection during the guarantee period, samples of the water systems shall be taken by the chemical treatment representative. The samples shall be analyzed by an independent testing laboratory and certified. The analysis made on the water shall be submitted to owner. The analysis report shall include recommendations as to any changes in the water treatment required.

G. Provide any and all necessary safety and government approval literature on recommended products to assure compliance with federal, state and local regulations.

3.03 INSTALLATION

A. Install chemical feeders per manufacturer's instructions. Chemical treatment equipment manufacturer shall supervise installation to ensure proper installation.

B. Install chemical feeders and equipment per manufactures recommendations.

C. Provide 316 stainless steel drip pan under chemical tanks and pumps. Pan shall be a minimum of 10 gauge.

D. Provide relief valve in the discharge of each pump.

E. Provide hose end drain valves at low points in piping.

3.04 PIPING SYSTEMS PREPARATION

A. General: After piping systems are erected and proven free of leaks provide services for piping systems flushing, cleaning, disinfecting, purging, rinsing and treating in accordance with specification.

3.05 CLEANING

A. Each new water system shall have an industrial strength cleaner added and circulated for a minimum of 24 hours when the system is initially filled with water. Cleaner shall be equal to Barclay Flushout.

B. After a complete flushing, each system shall be chemically treated with an inhibitor. The Water Treatment Contractor shall provide the proper amount of cleaner and inhibitor for each system, supervise the cleaning procedure and issue a written report to the Owner and Architect that each system has been properly cleaned, chemically treated and tested. The Mechanical Contractor shall perform the cleaning and flushing procedure under the supervision of the Water Treatment Contractor. The result of the initial tests shall be included in the report. All test apparatus, equipment and labor shall be provided by the Mechanical Contractor under this Section. Tests and cleaning will be witnessed by the Architect and Owner's representatives. Notify all parties 48 hours in advance of commencement of work.

END OF SECTION 232500

SECTION 233100 – SHEET METAL WORK AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install a complete system of air distribution, including accessories, to all areas indicated on the contract documents.

B. Create, coordinate and submit ¼" scale Coordination Drawing in accordance with Section 230500.

C. Provide all ductwork, fittings and accessories to make a complete and operational system in all respects.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. ASTM A 36/A 36M – Standard Specification for Carbon Structural Steel.

2. ASTM A 1008/A 1008M – Standard Specification for Steel, Sheet, Carbon, Cold Rolled, Commercial Quality.

3. ASTM A 1011/A 1011M – Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.

4. ASTM A 653/A 653M – Standard Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.

5. ASTM A 666 – Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

6. ASTM B 209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

7. ASTM B 209M – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

8. ASTM C 443 – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

9. ASTM C 443M – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric).

10. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

11. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.

12. NFPA 96 – Installation of Equipment for the Removal of Smoke and Grease-laden Vapors from Commercial Cooking Equipment.

13. SMACNA (LEAK) – HVAC Air Duct Leakage Test Manual.

14. SMACNA (DCS) – HVAC Duct Construction Standards – Metal and Flexible.

15. UL 181 – Factory-Made Air Ducts and Connectors.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for Additional Requirements.

C. Product Data: Provide data for duct materials, duct connectors and all accessories. Include sound attenuator test data in accordance with ASTM E477.

D. The Sheet Metal Contractor shall submit duct fabrication standards and methods of installation, in compliance with SMACNA and these specifications, for review and approval by the Architect, clearly indicating the combination of metal gauges and reinforcement intended for use for each pressure classification. Duct fabrication shall not be allowed until a satisfactory review of this Standard has been performed and fabrication drawings have been reviewed and coordinated. MERELY SUBMITTING COPIES OF THE SMACNA PRESSURE CLASS TABLES DOES NOT COMPLY WITH THIS REQUIREMENT.

E. Provide scaled ductwork fabrication drawings. Fabrication drawings shall be double line and as a minimum include elevations, dimensions, sizes, all offsets rises and drops, air distribution devices.

F. Provide scaled ductwork coordination drawings for all floors and systems in accordance with Section 230500, Submittals.

G. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA– HVAC Air Duct Leakage Test Manual.

H. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.

I. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed recommended fabrication and installation requirements.

J. Project Record Documents: Record actual locations of ducts, duct fittings and all accessories. Record changes in fitting location and type. Show additional fittings used.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. All ducts and fittings shall be manufactured by a sheet metal fabrication company whose primary business experience is the manufacture of commercial and industrial quality ducts and fittings. Sheet Metal Contractor shall have adequate

experience of building ductwork of the types required for this project as well as successful experience with projects of similar scope. Bids from sheet metal shops which do not meet the specified requirements shall not be acceptable.

C. **No Ductmate, Ward, Nixon or similar factory made slip-on connections will be permitted.**

1.08 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.09 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperature is less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 SHEET METAL WORK

A. General

1. Acceptable Manufacturers (Provided they are in compliance with these specifications)

a. Sheet Metal

1) All ducts and fittings shall be manufactured by a sheet metal fabrication company whose primary business experience is the manufacture of commercial and industrial quality ducts and fittings. Sheet Metal Contractor shall have adequate experience of building ductwork of the types required for this project as well as successful experience

with projects of similar scope. Bids from sheet metal shops which do not meet the specified requirements shall not be acceptable.

b. Sheet Metal Accessories

1) Access Doors

a) Ruskin or approved equal.

2) Flexible Connectors
a) Elgen Manufacturing or approved equal.

3) Flexible Ductwork
a) Flexmaster or approved equal.
b)

4) Fire Dampers
a) Ruskin or approved equal.

5) Fire/Smoke Dampers
a) Ruskin or approved equal.

6) Smoke Dampers
a) Ruskin or approved equal.

7) Nailor Industries Automatic Dampers Airfoil
a) Ruskin or approved equal.

8) Balancing Dampers (OBD)
a) Ruskin or approved equal.

9) Small Balancing Damper less than 48x12
a) Ruskin or approved equal.

2. Unless otherwise noted, all exhaust air ductwork of all types shall be constructed of galvanized sheet metal based on the "Pressure Class" indicated in the "Minimum SMACNA Construction Standards" table found hereinafter.

3. The drawings are diagrammatic and indicate the arrangements of the principal apparatus, ductwork and piping and shall be followed as closely as possible. Because of the scale of the drawings, it is not possible to show all offsets, rises, drops, rises, fittings, accessories, etc. The Contractor shall carefully investigate the structure, finish conditions, and

the work of other trades affecting the work and arrange ductwork, piping, equipment, accessories, etc. accordingly. Provide the best possible arrangement so as to provide the maximum headroom and access to apparatus while providing the minimum resistance to airflow. This work and any extra fittings and offsets required shall be included in the project without extra charge.

4. In addition to sheet metal ductwork provided under this Contract furnish and/or install accessories and devices furnished by others, including but not limited to smoke detectors. Provide and install miscellaneous sheet metal work including safing, mixing baffles, and blank off panels at unused louver areas.

5. All duct systems specified to be installed under this Contract, shall conform to the drawings, specifications, Standards, details and recommendations of the latest Edition of SMACNA "HVAC Duct Construction Standards - Metal and Flexible"; and "Round and Industrial Duct Construction Standards" (hereinafter referred to as Duct Manual). Where the requirements under this Section exceed the requirements of the Duct Manual, the specification shall govern. Wherever the word "should" appears, replace with the word "shall".

6. The Sheet Metal Contractor shall submit duct fabrication standards and methods of installation, in compliance with SMACNA and these specifications, for review and approval by the Architect, clearly indicating the combination of metal gauges and reinforcement intended for use for each pressure classification. Duct fabrication shall not be allowed until a satisfactory review of this Standard has been performed. MERELY SUBMITTING COPIES OF THE SMACNA PRESSURE CLASS TABLES DOES NOT COMPLY WITH THIS REQUIREMENT.

7. All galvanized steel sheet metal shall conform to ASTM A653/A653M (G-90) having not less than 1.25 oz. of zinc on each side of each square foot of sheet. All other duct materials shall be as hereinafter specified as applicable to this Contract.

8. The Sheet Metal Contractor shall install all duct mounted smoke detectors.

9. The Sheet Metal Contractor shall furnish and install all plenums with automatic or manual dampers attached to louvers.

10. The Sheet Metal Contractor shall fabricate and install all canopy hoods, flexible "elephant trunk" exhaust outlets as detailed or noted in the Construction Documents.

11. The Sheet Metal Contractor shall furnish and install exhaust ductwork from emergency generator outlet to exhaust louver including transitions, drains, access doors, flexible connections and baffles to isolate intake from exhaust.

12. There will be no supply and/or return air system ductwork internally lined unless otherwise noted.

13. The Sheet Metal Contractor shall clean and provide temporary caps on all ductwork during installation to prevent dust, dirt and debris from entering ducts during construction, including during shipping, handling and storage in the field.

14. All shop applied fabrication labels shall be applied to the exterior of the ducts. The Sheet Metal Contractor shall remove any material applied to the inside of the ducts before installation.

15. All inline fans shall have companion flanges intake and discharge for removal for servicing.

2.03 DUCT CONSTRUCTION

A. Duct Construction Schedule

Minimum SMACNA Construction Standards						
Ductwork Location	**Pressure Class Inches W.G.**	**Seal Class**	**Leakage Class**	**Material**	**Sound Lining**	**Table Notes**
General exhaust	-3	A	4	G-90	No	-

2.04 ADDITIONAL CONSTRUCTION REQUIREMENTS

A. Minimum Requirements

1. The minimum gauge for any steel duct over 2" or under -2" pressure class shall be 24 gauge except when specified heavier.

2. The minimum thickness of any aluminum duct shall be 0.040".

3. The minimum diameter of any tie rod shall be 1/2".

4. The maximum tie rod spacing shall be 42" unless specifically engineered in accordance with the SMACNA Industrial Rectangular Duct Standard.

5. When tie rods intersect, they shall be welded to each other.

6. No ductwork shall be constructed to less than ±2" w.g. This means nothing is constructed to a standard between –2” w.g. and +2” w.g.

7. **Duct dimensions indicated are clear inside dimensions. The sheet metal dimensions shall be increased to accommodate internal liner where liner is required.**

B. All joints and seams in all ductwork and casings shall be sealed to SMACNA Seal Class “A”. In finished areas, sealing compound shall be neatly applied to exposed ductwork and bands shall be provided over, to cover the sealant.

1. Some SMACNA constructions may not be suitable for the leakage classes specified even though they may meet the pressure class and should not be used.

2. Seal class A Welded means all welded (i.e. transverse joints, longitudinal seams, spiral seams, fire dampers, volume dampers or any accessories)and in addition it means continuously welded.

3. All sealants, adhesives and coatings shall be of approved kinds and qualities for each point of application, complying with recommendations for the use and storage.

4. The method of installation and materials for sealing the ductwork shall be submitted by the Sheet Metal Contractor for review and approval by the Architect, as part of the ductwork construction standards and installation submittal.

C. All longitudinal seams in all ductwork in excess of +2" w.g. or less then -2" w.g pressure class shall be made with formed Pittsburgh locks.

D. Grooved seam/flat lock/pipe lock joining methods is restricted to 2" W.G. pressure class only.

E. Button punch-snap lock seams are not to be used.

F. Concealed stainless steel ductwork shall have an ASTM mill rolled No. 1 or No. 2 D finish. Exposed stainless steel ductwork shall have an ASTM mill rolled No. 2 B finish, or higher grade as required by the Architect, with all welds ground smooth and final brushed with stainless steel wire brushes. All welds on exposed stainless steel ductwork shall be free of stain, burn-through, or discoloration to the satisfaction of the Architect.

G. Tie rods shall not be used in any plenum or large duct requiring internal access or use as an access pathway.

H. All ductwork required to be removable shall be companion flanged SMACNA Type T-22 for ductwork constructed to SMACNA Metal Duct Standard and companion flanged in accordance with Industrial Standards for ductwork required to be constructed to Industrial Standards.

I. Elbows

1. All dust collection ductwork elbows shall be a centerline radius equal to (2) duct widths or diameters. No reduction shall be allowed.

2. Radius elbows shall be used wherever possible. Where it is impossible or impractical to install a 1.5 times width to centerline radius of elbow (full radius elbow) lesser radii configurations shall be used, each with "radius-proportional" splitter vanes permanently installed within. No radius shall be less than 1.0 times the width. Provide square elbows in rectangular ducts with double thickness vanes with a minimum radius of 4 1/2". Square elbows may only be used when radius elbows will not fit and where specifically approved by the Architect prior to fabrication and/or as required by coordination shop drawings. All offsets shall be of the radium type.

J. Provide baffles and/or diffusion plates as required in all air handling units, to ensure proper air mixing, coil velocities and air distribution across filters or coils as determined in the field by the Architect, at no additional cost to the Owner.

K. It is the intent of this specification to provide a duct system with minimum resistance to airflow. All take-offs shall be throated and transitions made as gradually as possible. "Bullhead" or sharp take-offs shall not be acceptable.

L. In addition to SMACNA requirements, ductwork in return systems, ductwork in, ductwork in exhaust systems, ductwork in any Constant Volume System supply, return or exhaust valves shall be provided with:

1. Volume dampers in all branch takeoffs and in all main branches and ducts of all ductwork systems (supply, return and exhaust) for properly regulating and balancing airflow to all terminal outlets, for all duct sizes, whether shown on the drawings or not. **The above requirement is mandatory.**

M. All rectangular dampers shall be opposed blade and each shall be controlled by an approved galvanized locking quadrant indicating the damper position, as detailed on the drawings.

1. Volume dampers installed into ductwork that is specified to be externally insulated shall have extended activator/handle rods with extension bracket such that adjustment of the damper handle will not disturb the insulation.

N. Submit the sheet metal shop drawings to the Balancing Contractor of the project for his review and placement of dampers with the final balancing procedures and requirements in mind.

1. Coordinate the location and areas with the Balancing Contractor, and fabricate the ductwork system accordingly.

2. Provide any and all balancing dampers required by the balancing contractor at no additional cost.

O. In addition to SMACNA requirements, all round ductwork, if used in lieu of rectangular supply and/or return/exhaust systems shall conform to SMACNA.

1. The use of flat oval ductwork shall be acceptable only with prior written approval of the Architect. **Note:** Flat oval shall not be used under negative pressure.

2. Round duct shall be manufactured of spiral lock seam. Ductwork up to 12"ø and 2" w.g. pressure class can be manufactured with longitudinal lock seams.

3. All tees shall be conical.

4. All laterals shall be straight.

5. All taps through 10" diameter in size shall have a machine drawn entrance and all fittings shall have longitudinal seams, continuous-welded. Both sides of all welds shall be primed with zinc chromate.

6. All tap entrances shall be free of weld build-up.

7. Elbows in diameters 3" through 10" shall be 2-section stamped or pleated elbows. Larger elbows shall be gored construction. Elbows shall be fabricated to a centerline radius of 1.5 times the diameter. All gored elbows shall be fabricated according to the following schedule:

Elbows	# of Gores
Up to 35°	2
36° to 71°	3
Over 71°	5

8. All field joints in diameters through 48" shall be made with a 2" long slip-fit or sleeve coupling provided assembly is not hindered. Ductwork over 48", and for all sizes where disassembly and removal is required, shall be joined with Vanstone or shop fabricated flanges.

9. All flanges and taps into spiral ducts shall be factory or shop fabricated and installed as hereinbefore specified. Shipment of loose flanges or taps for field installation shall be avoided.

10. All access doors for round duct shall be furnished by the access door manufacturer. Round duct access doors shall be of low leakage sandwich type suitable for systems up to 8" pressure, positive or negative. Round duct access doors shall be insulated and shall be equivalent to Ruskin model ARDD.

11. Unless specifically noted otherwise or required by special constraints, all elbows on ductwork changing direction from vertical to horizontal shall be 1.5 times radius.

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2.05 SHOP APPLIED DUCT LINER (1 ½" = R of 6.3)

A. Interior supply and return ducts and plenums (other than outside air plenums), as hereinbefore specified to have internal duct insulation shall be lined with 1 ½ " thick fiberglass duct liner equal to Manville Permacote Linacoustic R-300 or Standard.

B. Liner shall meet the requirements of UL 181, ASTM C665 Bacteriological Standards, UL 723 Flamespread and NFPA 90A for flamespread and smoke developed ratings as borne out by tests and ratings of UL. Liner shall have an NRC no less than 0.80, based on Type A mounting as tested in accordance with ASTM C423-90 "k" factor not to exceed 0.25 (1") at 75°F mean temperature in accordance with ASTM C-518.

C. Maximum air friction in straight 24" diameter duct conveying 6200 cfm airflow at 2000 fpm velocity shall be 0.36" per 100'-0"

D. No erosion of insulation material shall occur below 5000 fpm duct velocity. Rigid board liner shall be constructed of strong glass fibers bonded with thermosetting resin.

E. All surfaces shall be protected with an acrylic coating.

F. Liner shall be applied with 100% coverage of approved fire resistant adhesive. Ducts over 20" in size in any direction shall be secured with mechanical fasteners ("stick-clips") on 12" centers and within 3" of ends.

G. Leading and exposed edges of liner joints shall be coated with fire resistant adhesive. Permacote-coated surface shall face the airstream.

H. The ductwork system shall be lined/sealed and installed in a manner to allow for low temperature air operation.

I. Care shall be exercised to ensure that no gaps or bare sheet metal exist, which might create condensation.

J. Acoustical liner installed in medium pressure ductwork and wherever lining starts abruptly from unlined ductwork shall be "nosed" with sheet metal flanging at all joints in accordance with SMACNA liner nosing details.

K. Liner shall be coated with a surface coating that does not support the growth of fungus or bacteria as determined by tests in accordance with ASTM C1071 and ASTM G21 and G22. Liner shall be sound absorptive.

L. The smooth black surface of the liner shall face the airstream and top pieces shall support the side pieces.

M. Lining on double wall duct systems may be completely covered with a layer of perforated minimum 24 gauge sheet metal (3/16 sq.in. holes on 7/16" staggered centers). The perforated sheet metal inner liner shall be secured with rivets and washers at intermediary points maximum 12" on center on all spans greater than 12" in width or height. Sheet metal nosing shall be provided to cover all insulation exposed-to-airstream edges, by bending of the sheet metal liner. Other methods of nosing, if different than the one specified, shall be submitted for review by the Architect prior to installation.

2.06 ACCESS DOORS

A. Provide access doors and frames in all supply, exhaust and return ductwork as required, to permit access to:

1. Automatic dampers

2. Other similar equipment

3. Fan Bearings enclosed in ducts.

4. For cleaning and inspection purposes

5. Where indicated on the drawings

B. Door Size

1. Ductwork

a. Minimum 16” x 12”

b. In ducts smaller then 12” they shall be 10” x 6” less then duct width except:

1) Terminal Box heating coil door may be 10” x 6”

c. Vacuum cleaning access door shall be 12” round.

2. Plenums

a. Shall be 20” x 56”

1) 18” x 45” door may be used only when 20” x 56” will not fit.

b. Larger door shall be provided if required for equipment removal. Coordinate with equipment.

C. Door Construction

1. Doors shall match material type and gauge of the duct system in which they are installed. This includes hardware such as bolts.

2. Minimum gauge shall be 20.

3. Pressure tested to ±15” wc

a. Leakage shall be zero at ±10” wg

4. Provide a neoprene gasketed around their entire perimeter.

5. Insulated or lined ductwork shall have insulated door

6. Insulated plenums shall have insulated door

7. Insulated doors shall be double wall.

8. Insulation between the metal panels shall be of the same thickness as the duct or panel adjacent to the access doors.

9. Plenum access doors shall be hung on heavy hinges and shall be secured in the closed position by means of latches.

10. Ductwork access doors shall be clamp type with a retaining chain or cable.

11. Ductwork access doors shall be similar to Ductmate Sandwich access door.

12. All plenum hinge doors shall be submitted with test (provide E leakage) data before approval.

2.07 FLEXIBLE CONNECTIONS (FANS)

A. Provide flexible connections of 4" minimum fabric width

1. Between ductwork and the inlets and outlets of all fans **except**:

a. Hazardous exhausts

b. Lab exhaust fans located indoors.

2. Equipment equipped with fans

3. All ductwork that crosses building expansion joints

B. The connections shall be placed as close to the equipment as practical except at fan suction connections and the clear gap at rest shall be not less than 3". At fan suction connections, locate flexible duct connection at least 3 duct diameters away from fan inlet connection.

C. There shall be no tension of the fabric under static or dynamic loads

D. All fabric for flexible duct connections to equipment shall be a minimum of 22 oz. glass fabric, double coated with neoprene, fire retardant, waterproof, airtight, and approved by UL, similar to Ventfabrics or Ventglass.

E. Exterior flexible connection shall be insulated type similar to Duro Dyne.

F. Flexible connections shall be fabricated from approved flameproofed fabric conforming to NFPA 90A. Asbestos shall not be acceptable.

G. Flexible connections shall be installed further upstream from fan powered equipment (in the main duct size) to prevent obstruction of the fan inlet due to suction of the fabric into the airstream.

H. Ductwork shall be increased in size where the flexible connections are located to prevent fully drawn in connections from blocking any duct area. Submit detail for review.

2.08 BLANK OFF PANELS FOR UNUSED LOUVER AREAS

A. Provide minimum 20 gauge sheet metal blank off panels for all unused louver areas:

1. All louver areas not enjoined or connected to an active plenum.

B. Exterior/visible face of blank off panel shall be cleaned and painted flat black, prior to installation.

C. Panels shall be screwed to louver frames and caulked to provide a weathertight seal.

D. Provide insulation of blank off panels. See specification Section 15081 - Ductwork insulation.

2.09 FLEXIBLE DUCTWORK

A. General

1. Flexible duct runs must not exceed 5'-0" in length. Flexible duct shall not exceed a maximum of 1/2" sag per linear foot when installed horizontally.

2. Flexible ductwork shall be supported at a maximum spacing of 2'-6", and as detailed on the drawings. Ductwork must not be compressed. Duct elbows must not exceed 45°.

B. Flexible Duct (Rigid)

1. Flexible duct shall be similar to Flexmaster Triple Lock Buck Duct Flexible Air Duct. Flexible duct (insulated) shall be UL 181, Class 0 listed air duct and constructed in accordance with NFPA 90A and 90B. It shall have a smoke/flame spread rating of 50/25.

2. Triple Lock Buck Duct shall be made from a tape of dead soft aluminum sheet, spiral wound into a tube and spiral corrugated to provide strength and stability. The joint shall consist of a triple lock that is mechanically performed without the use of adhesives to make a durable airtight seam. A double lock is not acceptable.

3. Insulated flex shall have a gray fire retardant polyethylene outer jacket with an 8 oz. density, 1 1/2" thick fiberglass insulation blanket, factory wrapped.

4. The flexible duct shall be supported as required.

5. Flexible ductwork shall be rated at 12" positive pressure. Duct from 3" to 16" shall have a negative pressure 12" and duct from 18" to 20" shall have a negative pressure of 8".

6. All flexible duct shall be individually cartoned and labeled for delivery to the job site for maximum protection.

7. Provide:

   a. Where indicated in construction greater then +2” or less then –2”.

   b. Upstream of supply boxes.

   c. Downstream or upstream of exhaust boxes when allowed.

C. Flexible Duct (Fabric)

1. Flexible duct shall be similar to Flexmaster Type 2. Flexible duct (insulated) shall be UL 181, Class 1 listed air duct and constructed in accordance with NFPA 90A and 90B. It shall have a smoke/flame spread rating of 50/25.

2. Duct fabric shall be of a heavy duty coated fiberglass cloth fabric. The fabric material shall be mechanically locked to the outside helix. (Use of adhesives to lock fabric in place is unacceptable.) The helix is constructed of a corrosive resistant galvanized steel, formed and mechanically locked to the duct fabric on the outside to prevent tearing of the flexible duct.

3. Insulated flex shall have a gray fire retardant polyethylene outer jacket with an 8 oz. density, 2" thick fiberglass insulation blanket, factory wrapped. Thermal insulation; R=5

4. The flexible duct shall be supported as required to prevent sagging. Flexible duct with excessive sagging will not be approved.

5. Flexible ductwork shall be rated at 12" positive pressure and 10" negative pressure. Negative pressure for 14"R and 16"R shall be 5" and negative pressure for 18"R shall be 1".

6. All flexible ducts shall be individually cartoned and labeled for delivery to the job site for maximum protection.

7. Provide:

   a. Where indicated in ±2” duct construction, except exhaust.

   b. Downstream of supply boxes.

2.10 DAMPERS

A. General

1. The minimum damper requirements shall be as indicated in the following table:

Damper Construction Table						
Type	**Approach Velocity (FPM)**	**Pressure Rating**	**Instantaneous Pressure Rating**	**UL555S Leakage Class**	**Blade Type**	**Listing**
Automatic dampers (AD)	4,500	6" w.g.	14" w.g.	I	Air Foil	N/A

2. Dampers in stainless steel ducts shall be stainless steel.

B. Automatic Dampers

1. All automatic dampers shall be furnished by the Sheetmetal Contractor. Dampers shall be single or multiple blades as required. Dampers shall be installed by the Sheetmetal Subcontractor, under the supervision of the Temperature Control Subcontractor. All blank-off plates and conversions necessary to install smaller or larger than duct size dampers shall be the responsibility of the Sheetmetal Subcontractor. All dampers shall be equal to RuskinModels CD-50 (rectangular) or CDR-25 (round).

2. All damper frames shall be constructed of extruded aluminum with 5” x 1” x 1.25” extruded aluminum and shall have flanges for duct mounting. All multiple damper sections must have jackshafts.

3. Damper blades shall not exceed 6” in width. All blades shall be of extruded aluminum airfoil type construction, fabricated from 6063-T5 aluminum. Blades shall be suitable for high velocity performance, ultra-low leakage type, with leakage not greater than6.2 cfm/sq.ft. at 4” w.g. pressure differential for 48” x 48” damper size, as published and certified under AMCA Certified Ratings Program. Damper leakage shall be less than 0.1% of total CFM at maximum damper system velocity.

4. All damper bearings shall be made of nylon or molded synthetic, bushings that turn in the bearings are to be oil impregnated sintered metal.

5. Replaceable butyl rubber seals shall be provided with the damper. Seals shall be installed along the top, bottom and sides of the frame and along each blade edge. Seals shall provide a tight closing, low leakage damper. Leakage and flow characteristic charts must be submitted to the Engineer prior to approval of dampers.

6. The HVAC Contractor shall provide an access door upstream and downstream of each automatic damper location.

2.11 PENTHOUSE ELEVATOR VENT ASSEMBLY

A. General

1. The Sheetmetal Contractor shall furnish and install a package penthouse elevator vent housing, to provide for venting of the elevator shaft, in accordance with the State Elevator Code.

2. The subject housing shall be similar to Model-PEV-400, as manufactured by Greenheck,Carnes or approved equal device.

3. The housing shall have the following features:

a. 2 sides of weather proof louvers

b. One side of 1/8” plate glass

c. UL labeled fire and smoke damper (pre-wired) with 120V input contacts for control of smoke damper operation via fire alarm system. Open on general fire alarm.

d. Shop assembled and shipped complete.

e. Louvers sized for actual elevator shaft area.

PART 3 - EXECUTION

3.01 SHEET METAL INSTALLATION

A. All ductwork shall be installed to true alignment, generally parallel or perpendicular to adjacent building walls, floors and ceilings, so as to present a neat and workmanlike appearance. All fabricated, stored and installed ductwork shall be protected with removable caps, plastic or other means to prevent dirt, water and debris from entering duct system. The Sheet Metal Contractor shall be responsible for maintaining a clean duct system and shall clean and/or replace any ductwork identified by the Owner or Architect as being deficient or dirty. The Sheet Metal Contractor shall be responsible for all costs associated with the temporary protection cleaning and/or replacement of ductwork. All fabrication labels shall be applied to the exterior of the duct. The Sheet Metal Contractor shall be responsible for the removal of all internal labels if such labels were incorrectly applied.

B. Care shall be paid to the exact locations of all sheet metal work with respect to equipment, ducts, conduits, piping, slabs, beams, columns, ceiling suspension systems, lighting fixtures and electrical, plumbing and fire protection systems in the building. Close coordination and cooperation shall be exercised with other Trades in locating the piping and equipment in the best interests of the Owner.

The drawings and specifications covering other work to be done in the building shall be carefully studied and arrangements shall be made to avoid conflict.

C. The drawings shall be followed where they are definite and provided such procedures do not cause objectionable conditions for equipment provided installed under this Contract. The drawings are intended to indicate the sizes of ductwork and if certain sizes are omitted or unclear, obtain additional information before proceeding.

D. Locate and size all openings for ductwork in the building construction. Provide all sleeves as hereinbefore specified. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

E. Provide access doors in ductwork at the following locations:

1. Both sides of automatic dampers

2. At all exhaust and intake plenums, doors shall allow full body access in all plenums over 4'-0" tall.

3. Otherwise indicated or specified

F. Provide labels with a minimum of 1" high red letters on white background. Each access door shall be labeled as follows (or worded as required by Code):

1. Automatic Damper

G. The installation of special items of equipment in the duct systems, including automatic dampers, thermostats, thermometers, duct airflow measuring devices and other related controls, shall be done by this Contractor under the direct supervision of the manufacturer of such controls.

H. All elbows, tees and branch takeoffs in round ductwork shall be made of the same materials as the ductwork.

I. Duct connections to equipment shall be in no case smaller than the equipment openings.

J. All openings for pitot tube traverses shall be fitted with neat removable plugs or caps. As a minimum, such openings shall be provided at every fan inlet and at

such other points as may be required for airflow measuring and balancing. Coordinate the location of plugs and caps with the Balancing Contractor.

K. All internally lined duct sections and joints shall be closely inspected by the contractor before and after each piece is erected. Loose edges, open joints, damaged areas and other defects shall be sealed securely so as to insulate all metal surfaces and so as to endure without falling in the presence of moving air. All liner applications shall comply with SMACNA "Duct Liner Application Standard".

L. Provide other miscellaneous sheet metal work shown on the drawings including blanking off portions of louvers not required for the specific usage and diffusion plates or mixing air scoops to allow for air mixing where job conditions require the provision of same. All above work shall be provided as part of this Contract at no extra cost to the Owner.

M. Where applicable and as approved by the Architect, all exposed ductwork shall be installed in a workmanlike manner to result in a neat appearance with no visible penetrations, screws, or other sheet metal imperfections.

N. Install all UL classified devices in accordance with their UL approved installation sheets.

O. Counterflashing of duct penetrations through roof shall be provided under this Contract.

3.02 DUCT HANGERS AND SUPPORTS

A. Provide suitable angle iron/strap hangers and supports inside the mechanical shafts, mechanical rooms and in ceilings of the buildings, and on the roof(s) as shown on the drawings (Architectural/HVAC). This work shall be performed as required by job conditions and as instructed by the Architect in the field to support all air distribution ductwork and devices in both horizontal and vertical planes.

B. When hanging and supporting the ductwork, the following shall be complied with:

1. Except as otherwise noted, ductwork up to 42" in greatest dimension shall be hung by using sheet metal bands secured as a minimum at (2) locations to the vertical sides of the ductwork and at (1) location under the duct.

All support systems shall be compatible with the building structure and roofing system as approved by the Architect.

2. Where ductwork major axis dimension is larger than 42", ductwork shall be hung by using rods of not less than 3/8" soft steel secured to angle iron trapeze support frame around ductwork with threaded nuts for securement and adjustment. All rods used on ductwork exposed in finished spaces shall be plain smooth rods threaded only at the ends.

3. Ductwork shall be securely attached to the building construction. The hanger design and spacing shall be governed by the major duct dimension and shall be in accordance with SMACNA Duct Manual, except as modified hereinbefore. Vertical ductwork shall be supported at each floor level in an approved manner using angles or channels attached to the ducts. The installation, when complete and under operating conditions, shall be free from chatter or vibration. If necessary to achieve this, additional supports and/or bracing shall be furnished without extra cost to the Owner. Supports and bars and similar items shall be primed and painted structural steel. Touch up with aluminum paint any surfaces where galvanizing is destroyed on indoor ductwork, zinc primer on exposed ductwork with a final coat of aluminum paint. Provide vibration isolation hangers where specified under Vibration Isolation Section of these specifications.

4. The Sheet Metal Contractor shall provide all supplemental steel required to support the ductwork in shafts, mechanical rooms or on the floor where structural steel is not properly positioned. Beam clamps shall be double sided.

5. The maximum hanger spacing shall be 10'-0" on centers and additionally on each side of an elbow or change-in-direction fitting.

6. In addition to the above, provide supports on each side of any duct mounted device, fans, coils, flow measuring stations, framed dampers, etc., to permit removal of the device without disconnecting adjacent duct sections.

7. Provide angle sway bracing to the structure wherever lateral loads would be imposed on the ductwork, including but not limited to:

    a. Elbows downstream of fan discharges.

    b. Ductwork exposed to the weather subject to wind loads.

8. Ductwork mounted on the roof or otherwise exposed to the elements shall be supported with frames constructed of steel angles and channels regardless of duct size.

    a. Coordinate all roof supports with General Contractor.

    b. Provide diagonal cross bracing between supports as required to sustain maximum area wind loads as dictated by the Architect.

9. The Sheet Metal Contractor shall provide expansion compensators, anchors and guides on all high temperature ductwork (breeching, high temperature supply/exhaust) as required.

3.03 SHEETMETAL TESTING

A. General

1. All ductwork that is required to be tested shall be tested on regular intervals as the job proceeds and shall be completed prior to enclosure in shafts, above ceilings or behind walls.

2. The Sheet Metal Contractor shall keep an up-to-date log of the ductwork tested for review by the Architect. The Sheet Metal Contractor shall notify all other Contractors when the testing is completed and accepted to permit enclosure of ducts.

3. The Sheet Metal Contractor shall furnish and install all blank off plates, blind flanges, safing, etc., necessary to isolate each section of duct being tested for leakage.

4. The Sheet Metal Contractor shall submit for review all proposed testing procedures, sample report, and equipment to the Engineer prior to proceeding. Additionally, the Sheet Metal Contractor shall notify the Engineer when testing is to occur so that the test can be witnessed at the Engineer's option.

5. All test equipment shall be calibrated per ANSI Standards prior to testing. Certified test reports shall be submitted to the Architect prior to commencement of the testing.

6. Testing Procedure

    a. The testing procedure shall be in accordance with SMACNA "HVAC Air Duct Leakage Test Manual".

b. The test pressure shall be the specified construction pressure of the duct system.

7. Scope of Testing

a. All ductwork (regardless of pressure class) that will be in inaccessible areas including, but not limited to, all ducts within shafts, above hard ceilings, and those that will be made inaccessible by the work of other Trades. (This shall include ±2" w.g. construction.)

b. All ductwork constructed to greater than +2" w.g. or less than -2" w.g.

c. All other sheet metal in duct systems constructed to ±2" w.g. shall be tested under normal fan pressure and shall not leak sufficiently to cause audible leaks or blowing detectable by hand. **If, in the opinion of the Architect, the ductwork does not appear to be constructed and/or sealed to the approved shop standards, the Architect may request any or all of this ductwork to be tested at the specified construction pressure.**

d. Allowable Leakage

1) The total allowable leakage shall be less than specified leakage class with no audible leaks.

2) If no leakage class is listed elsewhere, the system shall meet leakage Class 4.

3.04 DUCT CLEANING

A. Clean dust and debris from interior and exterior of all ducts using wet rags and vacuums.

B. Cover open ends of ductwork when installation does not proceed for more than one day. This requirement shall apply to each individual run of duct, such that no duct section shall remain open or unconnected for more than 8 hours.

END OF SECTION 233100

SECTION 233700 – REGISTERS, GRILLES AND DIFFUSERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all registers, grilles and diffusers including opposed blade dampers, frames and other accessories to make a complete system of air distribution.

B. All materials shall be new and manufactured for the specific purpose of distributing and controlling air flow.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. ADC 1062: GRD – Test Code for Grilles, Registers and Diffusers; 1984.

2. AMCA 500 – Test Method for Louvers, Dampers and Shutters; 1989.

3. ASHRAE 70 – Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

4. NFPA 90A – Installation of Air Conditioning and Ventilating Systems; 1993.

5. SMACNA (DCS) – HVAC Duct Construction Standard – metal and Flexible; 1995.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 2300500 for Additional Requirements.

C. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application and noise level.

D. Project Record Documents: Record actual locations of air outlets and inlets.

E. Submit air terminal performance data including static pressure, throw, velocity, airflow and acoustical performance. Data must indicate compliance with referenced Codes and Standards specified herein.

F. Manufacturer shall review requirements of outlets as to size, finish and type of mounting before submitting shop drawings and schedule of outlets.

G. Manufacturer shall check location of outlets and make necessary adjustments in position to conform with architectural features, symmetry and lighting arrangement before submitting shop drawings.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer shall certify cataloged performance and ensure correct application of air outlet types.

C. Manufacturer shall be responsible for examining application of each outlet and shall guarantee that each will provide comfortable space conditions without drafts at noted capacity.

1.08 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.09 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. Acceptable manufacturers contingent on compliance with specifications.
1. Titus or approved equal.

B. All air distribution devices shall be of steel or aluminum construction unless otherwise specified herein or scheduled on the drawings.

C. Distribution devices, except where such devices are specified or scheduled to be steel extruded aluminum, shall be factory primed and finish painted by the manufacturer in a color as approved by the Architect during shop drawing review, unless otherwise noted.

D. **All diffusers, grilles and registers must be compatible with the designed ceiling/wall type. Refer to architectural drawings for exact details of ceiling/wall construction.**

2.03 DIFFUSERS, REGISTERS AND GRILLES SHALL BE OF TYPE AS HEREIN SPECIFIED

Designation	Service	Air Pattern
A	Return/Exhaust	45° Deflection
B	Sidewall Supply (Adjustable)	45° Deflection

A. Type A (Return and Exhaust)

1. General return/exhaust registers shall be similar to Titus Model 350ZFL and shall be made of aluminum with (1) set of fixed blades, 42° deflection. Provide with countersunk holes and suitable frame to match ceiling or wall construction.

B. Type B (Sidewall Adjustable Supply)

1. Sidewall supply registers shall be similar to Titus 301FS and shall be made of aluminum, with mitered corners, double adjustable deflection core, and horizontal front louvers. Frames shall be suitable for construction adjacent to where registers are to be installed. Registers shall have countersunk screw holes.

PART 3 - INSTALLATION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instruction.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry and lighting arrangement.

C. Install diffusers to ductwork with air tight connections.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black.

END OF SECTION 233700

SECTION 233900 – FANS AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all fans of the various types, arrangement and sizes specified herein and as scheduled on the drawings.

B. Fans shall include all motors, drives, curbs, flashing, special coatings and accessories.

C. Furnish and install automatic dampers with all fans.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. AMCA 99 – Standards Handbook; 1986.

2. AMCA 210 – Laboratory Methods of Testing Fans for Rating Purposes; 1985.

3. AMCA 261 – Directory of Products Licensed to Bear the AMCA Certified Ratings Seal; 1995.

4. AMCA 300 – Test Code for Sound Rating Air Moving Devices; 1994.

5. AMCA 301 – Method of Publishing Sound Rating Air Moving Devices; 1994.

6. NEMA MG 1 – Motors and Generators; 1993 (and Revision 1).

7. UL 705 – Power Ventilators; 1994.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. Submit certified curves showing fan performance with system operating points plotted on curves.

D. Submit motor data sheets including motor efficiency and power factor at various loadings of nameplate horsepower. Motor efficiency and power factor shall be shown for 100%, 75% and 50% of nameplate horsepower. Submit data on efficiency and power factor required for motors 1 HP and above only. Motors shall have premium efficiency motors with minimum efficiency on motors listed in specification.

E. Submit bearing sizing calculations for each similar size and type of fan. Fan bearing calculations shall be based on fan at maximum operating conditions including belt pull. Calculations shall be done for both fan bearings and motor bearings. Calculations required on centrifugal fans, vent sets in-line fans, wall mounted propeller fans and vane axial fans only.

F. Submit sound power levels for each size and type of fan. Sound levels shall be in all (8) octave bands for discharge of fan, inlet to fan, and radiated noise through casing.

G. Submit certified shop drawings indicating all dimensional data, and operating and maintenance clearances.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Fans shall conform to most recent AMCA Bulletins regarding construction and testing. Fans shall be tested and rated per AMCA and shall be selected in proper operating range without motor overloading and fan surge.

C. Manufacturers must prove experience in the production of similar products of this type for at least ten (10) years prior.

D. Fans shall be air and sound certified in accordance with AMCA 210 and 300 and shall bear the AMCA seal.

E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. and other testing firm acceptable to the authority having jurisdiction and all suitable for the purpose specified and indicated.

1.08 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.09 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not operate fans for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings have been lubricated and fan has been test run under observation.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL

A. Manufacturers acceptable contingent upon product's compliance with the specifications are as follows:

1. Centrifugal Fans

    a. Greenheck Fan Corp. or approved equal.

2. Belted Fan Vent Sets

    a. Greenheck Fan Corp. or approved equal.

3. In-Line Tubular Centrifugal Fans

    a. Greenheck Fan Corp. or approved equal.

4. Wall Mounted Propeller Fans

    a. Greenheck Fan Corp. or approved equal.

B. Selection and Balancing

1. Provide and install items as listed in equipment schedules, as shown on drawings, and as specified, complete in all respects to the functions intended.

2. Provide fans capable of accommodating static pressure variations of ±10%.

3. Provide balanced variable sheaves for motors 15 HP and under.

4. Statically and dynamically balance fans in the field to eliminate vibration or noise transmission to occupied areas of the building. Provide certificate of compliance from manufacturer.

5. Provide OSHA and ANSI approved belt guards on interior mounted belt driven fans. Provide weatherproof ventilated housing for exterior mounted fans.

6. Provide special construction fans such as sparkproof, explosionproof, or coated fans as required by the schedule.

7. Provide safety, bird or insect screen where inlet or outlet is exposed.

8. All fans shall be manufactured in accordance with this specification even where techniques are required which are not considered standard by that manufacturer.

9. Verify fan arrangement with the Contractor including motor location for servicing and discharge arrangements for proper airflow.

10. Where fixed speed sheaves are specified for a particular fan, provide (2) additional sheaves (one motor and one drive) as necessary for final air balancing.

11. All (direct drive) fan shafts (which are connected to a variable speed controller) must be complete with a factory mounted shaft groundingbrush/device.

C. Painting

1. Each fan component shall be thoroughly cleaned, degreased and deburred before the application of a rust preventive primer.

2. Two (2) coats of a rust preventive primer shall be applied under a topcoat of air-dried epoxy or enamel. Minimum coating thickness shall be 5 to 6 mils. The final coat shall be applied after final assembly to all surfaces.

3. Special coatings shall be provided for corrosive exhaust systems as specified under the fan specification.

2.03 CENTRIFUGAL FANS

A. General

1. Fan selection and ratings shall be based on tests made in accordance with ASHRAE 51 and AMCA 210 and shall be licensed to bear the AMCA seal.

2. Fans shall be Class I construction and labeled UL 705.

3. Fans shall be backwardly inclined, airfoil, or flat blade type with a minimum of (10) blades.

4. Fans shall have sharply rising pressure characteristics at the operating point specified and shall be quiet and stable in operation. Horsepower characteristics shall be self-limiting and at peak value at the specified operating point.

5. The specified fan RPM, outlet velocity, and tip speed are the maximum acceptable. The motor horsepower, CFM, and static pressure are the minimum acceptable.

6. Fan arrangements shall be minimum AMCA pressure class, single-width, single-inlet or double-width, double-inlet, clockwise or counter-clockwise

rotation, shall be as scheduled on the drawings and as coordinated by the Contractors in the field.

7. Each fan shall be fully assembled with motor and drive on a structural steel base and run tested at the factory prior to shipment of the unit. Testing shall be conducted at the operating speed or maximum fan class speed. The total fan assembly shall be checked for balance and compared against the acceptable levels on the Rathbone Chart. The amplitude of vibration (displacement in mils) at operating speed measured at each unit fan bearing shall not exceed the values given in the following table:

Fan RPM	Displacement Mils
500	4.2
800	3.0
1100	2.3
1400	1.9
1700	1.6

Note: Displacement shall be peak-to-peak in X, Y and Z directions.

B. Fan Base

1. Fan with motor and drive shall be mounted on a structural steel base having a minimum 6" depth.

2. The base shall be electrically welded, and after welding, the base shall be cleaned, primed and painted to match fan coating.

3. Base steel sizing and construction shall be sufficient to allow the entire assembly to withstand the rigors of shipping and rigging.

4. Base shall be provided with lifting lugs and motor slide rails.

5. Fans with inertia bases as indicated in equipment schedules on mechanical drawings shall have structural bases constructed to accommodate concrete after installation. Bases shall be in accordance with Vibration Isolation Section.

6. All bases shall be constructed with gussetted brackets to accommodate field installed spring isolators as specified under Vibration Isolation Section.

C. Fan Housing

1. Fan housing shall be heavy gauge continuous welded steel construction with fan scroll and bearings supported from a structural steel framework. Minimum gauge construction shall be as indicated in the material construction schedule.

2. Fan housing shall be suitably braced to prevent vibration and pulsation.

3. Fans having wheel diameters 36" and larger shall have horizontally flanged split housings as required for installation.

4. Fan housing and inlet shall be constructed to allow the fan wheel(s) to be removed through the inlet opening when the inlet cone is removed.

5. A quick opening clean out door, shaped to conform with the scroll contour shall be provided with heavy-duty latches.

6. A 1/2" tapped 3/4" diameter pipe coupling drain connection shall be welded to the fan scroll at the lowest point.

7. Fans shall be convertible to a minimum of (8) standard discharge arrangements.

8. All fans shall be provided with a flanged discharge. The Sheet Metal Contractor shall provide the matching companion flange.

9. Fan cut-off shall be provided to deliver good pressure distribution.

10. A weatherproof housing shall be provided with ventilation grilles to cover motor and drive assembly for exterior mounted fans.

11. Exhaust fans serving kitchen hoods shall be so designed to satisfy NFPA 96, UL 762 and any other local codes required for kitchen hood exhaust system with cleanout door and grease drain with grease containment container.

D. Fan Inlet and Wheel Cone

1. Precision die spun or formed, and matched inlet and wheel cones shall be provided for streamlined airflow into the wheel to ensure full loading of the blades.

2. Inlet and wheel cones shall be hyperbolic. Radial side sheets are not acceptable.

3. Inlet cone shall be heavy gauge steel bolted to fan housing to allow for removal.

4. Fans having duct-connected inlets shall be provided with a flanged inlet collar with matching companion flange.

5. Fans which are not duct connected shall be provided with inlet screen(s). Inlet screen(s) shall be a nominal 1" by 1" mesh fabricated 10-gauge steel.

6. Hubs shall be straight bored, keyed and set screwed to shaft for positive attachment. Hubs shall be securely riveted to the backplate or center plate.

7. Bushed hubs are not acceptable.

8. Double width double inlet fans shall be a single wheel of the common center plate design or (2) single-width single-inlet wheels back to back, each keyed and set screwed to a common shaft.

9. Fan blades shall be continuously welded to the inlet hub and the backplate.

10. Wheel center plate or backplate shall be heavy gauge steel construction with a minimum gauge as indicated in material construction schedule.

11. The fan shaft shall be solid AISI C-1018, 1040 or 1045 hot rolled steel, accurately turned, ground and polished, and ring gauged for accuracy.

12. Recommended bearing manufacturer tolerances must be met in the contact area for bearings.

13. All shafts must be dial indicator inspected for straightness after the keyways are cut.

14. Fan shaft shall be coated with a rust inhibitive coating.

15. Fan wheel shall be statically and dynamically balanced prior to fan assembly.

16. The entire rotating assembly shall be designed so the first critical speed is a minimum of 25% greater than the fan design speed.

E. Fan Shaft Bearings

1. Fan bearings shall be foot-mounted type, bolted on a rigid welded steel framework integral with the housing.

2. Bearings shall be sized for a minimum L-10 life of 200,000 hours at maximum fan class operating conditions including belt pull. Bearings shall be selected in accordance with standards set forth by the Anti-Friction Bearing Mfrs. Assn.

3. The bearings shall be double-row spherical, self-aligning, grease lubricated, roller bearings housed in a horizontally split pillow block housing.

4. Bearings shall be SKF-SAF Series 22500 or Linkbelt P-B22400H.

5. Extruded copper grease leads shall be provided to an easily accessible location.

6. Direct drive fans must have shaft grounding device.

F. Fan Drive

Fans shall be belt driven unless otherwise specified. The drive shall be a multiple V-belt type sized for 1.65 times the fan motor horsepower. Sheaves shall be fixed or adjustable based on fan motor horsepower as specified hereinbefore. The fan sheave shall have a tapered lock, split and keyed hub.

1. Motors shall meet requirements specified in Special Conditions Section.

2. Motors shall be 1800 rpm for all belt driven fans and 1200 RPM or 900 rpm for all direct driven fans.

3. An OSHA approved type fan drive guard shall be provided with provision for RPM measurement, without removing the guard. The guard shall be made of 1/2" 16 gauge flattened expanded steel, wrapped around a 16 gauge channel frame suitably braced to prevent vibration. Paint guard with coating similar to fan.

4. Fan belts shall be oil resistant 24,000-hour non-static belts.

G. Fan Material Construction Schedule

1. The following schedule indicates minimum allowable steel gauge thicknesses for construction:

Housing				Wheel			
Wheel Size	**AMCA Pressure Class**	**Side Sheet**	**Scroll**	**Blades**	**Wheel Cone**	**Back-Plate**	**Center-Plate (DWDI)**
12	1	12	14	16	10	8	8
thru	2	10	12	16	10	8	8
22	3	10	10	16	10	8	8

Housing				Wheel			
Wheel Size	**AMCA Pressure Class**	**Side Sheet**	**Scroll**	**Blades**	**Wheel Cone**	**Back-Plate**	**Center-Plate (DWDI)**
24	1	12	14	16	10	8	8
thru	2	12	14	16	10	8	8
33	3	8	10	16	10	8	1/4
36	1	12	14	16	10	8	8
	2	12	14	16	10	8	8
	3	8	10	16	10	8	1/4
40¼	1	12	12	14	10	8	8
thru	2	12	12	14	10	1/4	1/4
44½	3	8	10	14	10	1/4	1/4
49	1	12	12	12	10	8	8
	2	12	12	12	10	1/4	1/4
	3	8	10	12	10	1/4	1/4
54¼	1	12	12	12	8	8	1/4
	2	12	12	12	8	1/4	5/16
	3	8	10	12	8	1/4	3/8
60	1	12	12	12	8	3/16	1/4
	2	12	12	12	8	3/8	3/8
	3	8	10	12	8	3/8	3/8
66	1	8	8	10	1/4	3/16	5/16
	2	8	8	10	1/4	3/8	3/8
	3	8	8	10	1/4	3/8	3/8
73	1	8	8	8	1/4	1/4	5/16
	2	8	8	8	1/4	3/8	3/8
	3	8	8	8	1/4	3/8	3/8

2. Manufacturers shall use their standard gauges if heavier than those indicated above. Information on standard construction shall be made known if requested by the Architect/Engineer.

2.04 PLENUM FAN ASSEMBLIES

A. General

1. All fans shall meet the airflow performance specified and shall not exceed the break horsepower or sound power levels specified on the mechanical equipment schedule.

2. Fan performance shall be based on testing and be in accordance with AMCA Standards 210 and 300. All fans shall have a steep pressure/volume curve.

3. Fans shall be AMCA certified for air and sound performance.

4. Fan(s) shall be plenum type, designed for horizontal airflow

5. Fans shall be AMCA arrangement 3 with airfoil backward-inclined blades, AISI C-1045 hot rolled steel turned/ground and polished shaft. Wheel and frame shall be of welded construction

6. Completed isolated assemblies shall be dynamically balanced in all 3 planes to category BV-2 for fan 5 hp or less and category BV-3 for fans greater than 5 hp as required by ANSI/AMCA Standard 204 in the horizontal, vertical and axial planes meeting “Factory Filter In” and “Startup Filter Out” requirements.

7. Fans shall be single width airfoil centrifugal plenum type, designed for rugged industrial duty and suitable for continuous operation. All fans larger than 18” diameter shall have a minimum of 12 blades. Fans shall be selected to operate at a point no higher than 90% of the peak static pressure rating as defined by the fan performance curve at the selected operating speed.

8. Fan shafts shall be solid AISI 1040 or 1045 steel. Shafts shall be turned, ground and polished to a minimum 16-micro-inch finish. Shafts shall be sized to run at a minimum of 20% greater than the maximum AMCA class speed.

9. Inlet cones shall be precision spun or die formed. Inlet cones shall be aerodynamically matched to the wheel side plate to provide streamlined airflow in the wheel and ensure full loading of the blades.

10. All fan section access doors shall have one (1) latch, which requires a tool to open.

11. Fans shall be isolated from bulkhead walls by means a neoprene coated flexible fabric connector.

B. Motor

1. Motor shall be TEFC see Motor specification section.

2. Motors shall have a 1.15 service factor. [Motors shall be suitable for use with variable frequency drives].

C. Drive

1. Provide belt or direct drive as indicated.

2. Belt drive

a. Belt drive shall have fixed pitch sheaves. Drive belts shall have a 1.50 service factor.

b. Drive assembly shall be furnished with a totally enclosed beltguard.

c. Sheaves and Belts: All sheaves shall be selected with a 1.5 service factor. Sheaves shall be machined from a close grain cast iron and statically balanced by the manufacturer. Drive belts shall be a V type. One variable pitched sheave shall be provided on motors from 1 to 15 horsepower. Fixed pitch sheaves shall be provided on motors larger than 15 horsepower. Where fixed sheaves are provided one sheave exchange shall be provided as required FOB the factory. Belts shall be oil and heat resistant.

3. Direct drive

a. Motor shall be 1200 rpm or less.

b. Must have fan shaft grouding device.

D. Bearings

1. Fan bearings shall be heavy-duty, pillow block, self-aligning ball or roller type, and grease lubricated. Using AFBMA ratings, bearings shall be selected for a minimum L-10 life of 100,000 hours. Both bearings shall have the same bore, type and manufacturer. At least one bearing shall be fixed. Both bearings being the floating type is not acceptable. Extended flexible lube lines shall be provided and extended to the drive side of the fan.

E. Base

1. Fans shall be supplied with following features: 2” nominal deflection isolators, fan manufacturer's standard paint finish, inlet

2. Fan assemblies shall be designed for heavy-duty industrial applications with no structural resonance occurring within the fan operating speed range when isolated. Fan framing assemblies shall be fabricated from structural steel. Formed members are not acceptable. This structural steel shall be welded together to form a rigid integral base. Fan assemblies shall be independently isolated with spring-type vibration isolators.

2.05 IN-LINE TUBULAR CENTRIFUGAL FANS

A. Provide belt driven centrifugal type in-line fans with capacities as indicated in the equipment schedules on the mechanical drawings.

B. AMCA pressure Class I or Class II as indicated in the equipment schedule.

C. Fan housing shall be heavy gauge galvanized steel welded to a rigid galvanized structural steel framework or steel coated with an epoxy finish. Minimum thickness of epoxy finish shall be 5 mils. Fan housing shall be provided with mounting brackets at both inlet and discharge suitable for hanger rods or bolting directly to structure.

D. The housing interior shall be lined with 1/2 inch acoustical insulation.

E. Fan housing shall have inlet and outlet connections flanged. The outlet duct collar shall include an aluminum backdraft damper and shall be adaptable for horizontal or vertical discharge.

F. Fan inlet cone shall have a die spun hyperbolic shape and be matched to the wheel cone to ensure full loading of fan blades and to maximize efficiency.

G. Fan wheel shall have single thickness backward inclined blades or true hollow airfoil shaped blades. Wheel characteristics shall be non-overloading.

H. Fan inlet cone, wheel cone, blades and backplate shall be constructed of heavy gauge aluminum or steel. Steel construction shall be coated with an epoxy coating having a minimum thickness of 5 mils.

I. Blades shall be welded to wheel cone and backplate.

J. Wheel shall be statically and dynamically balanced.

K. Drive shaft shall be ground and polished high grade steel supported by permanently lubricated sealed ball bearings housed in a cast iron pillow block housing.

L. Bearings shall be sized for a minimum of L-10 life of 200,000 hours at maximum fan operating conditions including belt pull. Bearings shall be selected in accordance with standards set forth by the Anti-Friction Bearing Mfrs. Assn.

M. Drives shall be sized for a minimum of 1.65 times the fan motor horsepower. Sheaves shall be adjustable and have a tapered lock, split and keyed hub. Belts shall be oil resistant, 24,000-hour non-static type.

N. Fan shall be suitable for horizontal or vertical mounting.

O. Motor, drive, and bearings shall be out of the exhaust airstream and housed to facilitate ease of maintenance. Motor cooling shall be through the fan drive and

motor housing. Housing for motor drive and bearings shall be of the same construction as the fan housing. The motor shall be mounted on vibration isolators.

P. Motors shall be in accordance with Motors Section of the Special Conditions.

Q. Fans shall be constructed in accordance with AMCA 99-0401 Type A, B or C.

R. Provide with 1/2" by 1/2" galvanized wire mesh attached to a galvanized structural steel frame. Frame shall be bolted to the flanged housing construction.

S. Provide thrust arrestors as required to limit movement of the fan upon start-up.

2.06 WALL MOUNTED PROPELLER FANS

A. Provide propeller type sidewall fans with capacities as indicated in the equipment schedules on the mechanical drawings.

B. Entire fan shall be of heavy-duty industrial type construction.

C. Fan panel shall be constructed of heavy gauge plate steel with a die formed or spun venturi shaped inlet cone built into the panel.

D. Fan panel edges shall be formed back. Corners shall be welded and ground.

E. Fan wheel, motor, drive and bearings shall be supported from fan panel using structural channel or heavy plate steel. Bearing housings and motor base shall be mounted on a heavy steel plate spanning the (2) vertical support members. All construction shall be welded or bolted.

F. Wheel shall have a minimum of (4) propeller blades, die formed constructed of heavy gauge steel or aluminum. A reinforcing gusset shall be welded or riveted to the blades and to a machined hub.

G. Drive shaft shall be ground and polished high-grade steel supported by grease-lubricated ball bearings housed in a cast iron pillow block foot mounted housing.

H. Bearings shall be sized for a minimum L-10 life of 100,000 hours at maximum fan operating conditions including belt pull. Bearings shall be selected in accordance with standards set forth by the Anti-Friction Bearing Mfrs. Assn.

I. Drives shall be sized for a minimum of 1.65 times the fan motor horsepower. Sheaves shall be fixed or adjustable depending on fan motor horsepower and shall have a tapered lock, split and keyed hub. Belts shall be oil resistant, 24,000-hour non-static type.

J. Motor shall be in accordance with the Motor Section of the Special Conditions. Motor shall be mounted on an adjustable slide base.

K. Fans shall be provided with motor side and fan side guards where open or unprotected. Guards shall be 1/2" by 1/2" rod or wire made of galvanized steel. Guard shall completely enclose motor drive and support assembly for motor side guard.

L. Provide fans with heavy duty Class I low leakage, gasketed, multi-blade automatic damper. See Sheet Metal Section and ATC Section for damper specification.

M. Fans shall be constructed in accordance with AMCA 99-0401 Type A, B or C.

N. Where indicated in equipment schedule on mechanical drawings, fans shall be provided with explosion proof motors.

PART 3 - FAN INSTALLATION REQUIREMENTS

3.01 INSTALLATION

A. Fans shall be installed in accordance with manufacturer recommendations, Contract Drawings and reviewed submittals.

B. Fans shall be installed so as to ensure easy accessibility for service or removal or replacement of all components such as, but not limited to, fans, motors, belts, drives, bearings, dampers, actuators, isolators, and field connections.

C. The HVAC Contractor shall install all motors and drives shipped loose. Fans shall be installed and tested, and shall be made fully operational by the HVAC Contractor.

D. Provide fixed sheaves as necessary for final air balancing. The Contractor shall install the fixed sheave after balancing with the Contractor to adjust the fans.

E. Manufacturer shall include the adjustment of pitch for adjustable pitch fans as required by balancing.

F. Make all penetrations through vertical walls watertight. Submit methods of sealing to Architect/Engineer for review and approval.

G. All fans shall have flexible inlet and outlet couplings to prevent vibration transmission to ductwork.

H. The Contractor shall assemble all loose parts including motors and drive assemblies on site and shall vibration balance the fans in the field. Field adjustment including belt alignment, wheel balancing, belt tension, greasing of

bearings, installation of belt guards, and other loose parts shall be provided by the HVAC Contractor.

3.02 COORDINATION

A. The Contractor shall coordinate the fan arrangement with the coordinated ductwork layout prior to ordering the fan. The Contractor shall provide all labor and materials necessary to change fan arrangement in the field when fan arrangement does not match ductwork.

B. The inlet and discharge ductwork shall have a minimum straight run of (2) fan diameters upstream and downstream of the fan. The Contractor shall notify the Engineer in writing if these conditions cannot be achieved. Installation of improper inlet/discharge conditions without the review of the Engineer shall be corrected in the field at no cost to the Owner.

C. The discharge duct arrangement shall comply with AMCA recommended layouts for elbows after fans.

D. The Contractor shall provide all supplemental steel, supports, rods and hangers necessary to hang or mount fans. Supports shall include thrust restraint as required by the fan manufacturer.

E. The Contractor shall revise the fan in the field if job conditions require changing of orientation, at no cost to the Owner.

F. The Contractor shall receive and inspect all fans and motors to make sure that all fans are received without defect. All defective or damaged fans shall be returned to the manufacturer by the Contractor for replacement.

G. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc. Protection shall include temporary plastic wrap to keep equipment in original factory condition. Fans used for temporary ventilation during construction shall be totally cleaned and refurbished prior to turnover to the Owner.

H. The HVAC Contractor shall mount and vibration balance all fans. The Electrical Contractor shall furnish and install power wiring to the fan motor and verify proper fan rotation. The HVAC and Electrical Contractors shall coordinate the starter requirements to ensure that the proper starter is installed for non-standard motors. The ATC Contractor shall wire all interlocking wiring to the fan including smoke detector wiring for fan shutdown.

I. The HVAC Contractor shall mount all automatic control dampers on the fan either shipped loose or provided by the ATC Contractor.

J. The HVAC Contractor shall mount all field mounted flow measuring devices on the inlet or discharge of the fan prior to fan installation.

END OF SECTION 233900

SECTION 235224 – CONDENSING BOILERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.02 WORK INCLUDED

A. Furnish and install finned water tube gas fired hot water boilers of the size, capacity and quantity as shown on the contract drawings including individual hot water circulating pumps.

B. Each boiler shall have all self-contained controls and safety devices and shall be capable of independent operation.

C. Each boiler shall include an AGA certified and listed burner, controls, pump, combustion chamber, water section with tubes and a complete insulated jacket.

D. The gas train shall be IRI accepted, including all controls.

E. The performance ratings shall be in accordance with TRS-Testing and Rating Standards for Boilers.

F. All boilers shall be installed in accordance with all local, State and Federal codes.

G. Secure all permits and local/State approvals for the installation of the boilers including all operating and installation permits.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. International Mechanical Code, 2003 including Connecticut addendums.

2. International Energy Code, 2009 including Connecticut addendums.

3. AGA (DIR) – Directory of Certified Appliances and Accessories.

4. ANSI Z21.13 – Gas-Fired Low-Pressure Steam and Hot Water Boilers.

5. ASME (BPV IV) – Boiler and Pressure Vessel Code, Section IV – Rules for Construction of Heating Boilers.

6. ASME (BPV VIII, 1) – Boiler and Pressure Vessel Code, Section VIII, Division 1 – Rules for Construction of Pressure Vessels.

7. HI (TRS) – Testing and Rating Standard for Boilers; Hydronics Institute.

8. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).

9. NFPA 54 – National Fuel Gas Code.

10. NSPA 58 – Storage and Handling of Liquefied Petroleum Gases.

11. NFPA 70 – National Electrical Code.

12. UL (GOED) – Gas and Oil Equipment Directory; current edition.

1.05 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. See Section 230500 for Additional Requirements.

D. Product Data: Provide data indicating general assembly, components, controls, safety controls and wiring diagrams with electrical characteristics and connection requirements.

E. Manufacturer's Instructions: Indicate assembly, support details, connection requirements and include start up instructions.

F. Manufacturer's Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list and maintenance and repair data.

H. Warranty: Submit manufacturers warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.07 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum ten (10) years of documented experience.

1.08 REGULATORY REQUIREMENTS

A. Conform to all applicable code and NFPA 70 for internal wiring of factory wired equipment.

B. Conform to ASME/BPV IV and BPV VIII and ANSI Z21.13 for boiler construction.

C. Units: AGA certified and listed and UL labeled and listed.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Protect units before, during and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Provide a five (5) year warranty to include coverage for heat exchangers.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 GENERAL – High Efficiency Condensing Boilers

A. Acceptable manufacturers constitute the contingent with specification:

1. Lochinvar (Crest Series) or approved equal.
2. Each boiler efficiency factor must meet or exceed the local utility rebate demand/requirements.

2.03 BOILERS

A. Furnish and install in accordance with plans and specifications including manufacturer’s recommendations, state and local code. The hot water boiler(s) shall be similar to Lochinvar, Crest or engineer approved equal rated at 60 psig design pressure and capacity as scheduled on the drawing and specifications.

2.03 BOILER DESIGN

A. The boiler shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. The boiler shall have a fully welded 316L stainless steel, fire tube heat exchanger. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger construction. The heat exchanger shall be designed for a single-pass water flow and will drain condensation to the bottom of

the vessel. The complete heat exchanger assembly shall carry a ten (10) year limited warranty.

B. The boiler shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.13 test standard for the U.S. and Canada. The boiler shall comply with the energy efficiency requirements of the latest edition of International Energy Code, the ASHRAE 90.1 Standard and the minimum efficiency requirements of the latest edition of the AHRI BTS-2000 Standard. The boiler shall operate at a minimum of 92% thermal efficiency at full fire as registered with AHRI. All models shall operate up to 99% thermal efficiency with return water temperatures at 90°F or below. The boiler shall be certified for indoor installation.

C. The boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. Two burner/flame observation ports shall be provided. The burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates. The boiler shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The boiler shall operate in a safe condition at a derated output with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.

D. The boiler shall utilize a 24 VAC control circuit and components. The control system shall have a liquid crystal touch screen display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi; outlet water temperature sensor; return water temperature sensor; outdoor air sensor, flue temperature sensor; high and low gas pressure switches, low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.

E. The boiler shall feature the “Smart Touch™” control with a liquid crystal touch screen display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, domestic hot water prioritization and PC port connection. The boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime, ignition attempts, ignition failures, and modulation. The boiler shall have a built-in “Cascade” to sequence and rotate the while

maintaining modulation of up to eight boilers without utilization of an external controller. The internal "Cascade" function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours. The boiler shall be capable of controlling isolation valves during heating operation and rotation of open valves in standby operation for full flow applications. The control must come with standard Modbus communication protocol. The boiler shall have an optional gateway device which will allow integration with LON or BacNet protocols.

F. The boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Louver Proving Switch, Tank Thermostat, Remote Enable/Disable, System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single phase on models up to 3,500,000 Btu's/Hr.

G. The boiler shall be installed and vented with a Direct Vent system with horizontal sidewall termination of both the exhaust vent and combustion air. The flue shall be Category IV approved Stainless Steel sealed vent material terminating at the sidewall with the manufacturer's specified vent termination. A separate pipe shall supply combustion air directly to the boiler from the outside. The air inlet pipe must be sealed and may be other materials listed in the Installation manual. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 100 equivalent feet. The air inlet must terminate on the same sidewall as the exhaust.

H. The BOILER shall be suitable for use with polypropylene glycol, up to 50% concentration without contingencies.

2.04 EMISSIONS

I. Burner Boiler design shall produce NOx emission of less than 10 PPM at full firing rate.

2.05 START-UP

A. Local representative shall have an in-house service department which is available 24 hours a day, 7 days a week for emergency service. The representative shall be in the regular business of selling and servicing commercial and industrial boiler equipment. Subcontracted start-up and warranty labor to a company other than boiler representative shall not be acceptable. This shall insure single point responsibility.

B. An authorized service technician shall start, test, and adjust the boilers and furnish a start-up report attesting to a successful light off for review by the engineer. Start-up report shall include a printout from an ECOM combustion analyzer for low, medium, and high fire. Gas analysis must include the following:

- Air temperature
- Gas temperature
- Oxygen as a %
- CO as a %
- NO as ppm
- NO2 as ppm
- NOx as ppm
- CO2 as a %
- Efficiency as a %
- Losses as a %
- Excess air as a %

C. This printout shall be submitted with the start-up report for review, and approval by the mechanical engineer.

D. Provide one day of training for the operating personnel to be performed at the jobsite. Contractor shall coordinate with the manufacturer's representative for start-up and training services.

2.06 MANUFACTURER'S WARRANTY

A. All equipment shall be guaranteed against defects in materials and workmanship for a period of 12 months from the date of start-up, or 18 months from the date of shipment, whichever comes first. The warranty shall include parts only to repair or replace all defective parts and material at no charge to the owner

B. The pressure vessel shall be warranted for 20 years against thermal shock.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Pumps shall be installed with manufacturer's recommendations, Contract Drawings, and reviewed submittals.

B. Pumps shall be installed so as to ensure easy accessibility for service or removal and replacement of all components such as, but not limited to, impellers, motors, drive couplings, bearings, strainers, other pump appurtenances, isolators, and flex connections.

C. The Contractor shall properly protect all equipment to prevent damage from water, dirt, etc. Protection shall include temporary plastic wrap to keep equipment in original factory condition.

D. Install in accordance with NFPA 54 and NFPA 58.

E. Install boilers on 4 inch concrete housekeeping pads.

F. Provide connections to the natural gas service connection in accordance with NFPA 54, AGA Z223.1 and NFPA 58. Pipe all gas train vents to the outdoors in accordance with all local and State codes.

G. Provide piping connections and accessories as indicated.

H. Connect each boiler to a common all stainless steel breeching and stack system.

I. Pipe water relief valves to nearest floor drain.

J. Install circulator, including all valves and accessories on each boiler.

K. Provide complete electrical connections to all boilers.

L. Pipe all gas train vents to outdoors.

3.02 BOILER START-UP SERVICE

A. Each boiler shall be set-up and adjusted by service personnel trained by the boiler manufacturer and regularly engaged in servicing gas burners of the type and capacity provided, and who maintains twenty-four (24) hours service capability. Submit for approval the name and address of the gas burner start-up and service contractor.

B. The burner service contractor shall check all parts of the installation applicable to the burner to be certain that piping installation, wiring, control installation, etc. shall be in accordance with the recommendations of the burner manufacturer. Upon initial start-up, the burner shall be operated and adjusted to obtain the performance criterias specified by the burner manufacturer. Unit efficiency based on the flue gas analysis shall not be less than eight (80) percent. The burner shall be adjusted for each connected fuel as applicable.

C. After final adjustment, the Contractor shall record and submit to the Architect the following data:

1. Incoming gas train pressures – “Hg”.

2. Gas pressures to nozzle – psig (low and high fire).

3. Stack draft – “H2O (positive or negative)”.

4. Fire box pressure – “H2O (positive or negative)”.

5. Gross tack temperature - °F.

6. Room temperature - °F.

7. Net stack temperature - °F.

8. CO2 in fire box - %CO2.

9. CO2 in flue gases - %CO2.

10. Smoke reading on the Bacharach scale.

11. Calculated combustion efficiency.

D. Readings and calculations shall be made for both high and low fire settings. Where modulating firing control is used, six (6) progressive sets of readings and calculations are required.

E. The above adjustments and group of readings shall be re-checked after a period of at least two (2) weeks, but not greater than four (4) weeks of essentially normal operation in terms of building load. The second group of readings shall also be recorded and submitted to the Architect.

F. During at least one (1) of the above two (2) adjustment sessions, the Owner’s maintenance personnel shall be present and shall be instructed in the proper operation of the burner and its associated control system. During the start-up phases, the operation of the flame safeguard control, all operating and limit controls, as well as the function of the low water cut off shall be checked and the report submitted to the Architect shall certify that these functions have been checked and that operation is satisfactory. Notify the Architect and Owner at least one (1) week prior to final start-up and demonstration.

G. The burner service contractor shall, upon completion of the installation, make available to the Owner an annual service agreement covering all labor and material required to efficiently maintain the oil burners after warranty.

END OF SECTION 235224

SECTION 238235 – TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract

C. Section 230500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and install all terminal heat transfer units of the type, size and capacity as scheduled.

B. Units shall be UL and AGA listed in accordance with the specific unit’s heat transfer design and construction.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. UL 1025-89 – Electric Air Heaters.

2. UL 1042-86 – Electric Baseboard Heating Equipment.

3. ASHRAE 90.1 – Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.

4. NFPA 54 – National Fuel Gas Code.

5. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

6. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.

7. NFPA 211 – Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances.

1.05 SYSTEM DESCRIPTION

A. Furnish and install all radiation, unit heaters, radiant panels, controls, piping, wiring, enclosures, access doors, etc. to make a complete and operational system.

B. All enclosures shall be installed with aligning strips, plaster frames and end trims so as to provide a neat architectural finish.

C. All equipment shall be new and shall be of the type, style, size and capacities as scheduled. All radiation enclosures shall be continuous and of the same finish and style as adjacent enclosures.

1.06 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. Product Data: Provide typical catalog of information including arrangements.

D. Shop Drawings:

1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers and comparison of specified heat required to actual heat output provided.

a. Indicate cross sections of cabinets, grilles, bracing and reinforcing, mounting details and insulation if required and typical elevations.

b. Indicate flows, pressure drops (including interconnecting piping for radiant panels), heat outputs and mean temperatures.

c. Indicate mechanical and electrical service locations and requirements.

E. Manufacturer's Instructions: Indicate installation instructions and recommendations.

F. Project specific installation instructions and details.

G. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets and ceiling panels required for access or valving.

H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listings.

I. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.07 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.08 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years of documented experience.

C. Products Requiring Electrical Connection: Listed and classified by Underwriter's Laboratories Inc. testing firm acceptable to the authority having jurisdiction and suitable for the purpose specified and indicated.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Delivery of materials shall be made to the project by the materials supplier in accordance with the instructions to the Contractor.

C. The Contractor shall provide adequate locked storage space with shelving for the materials, shall be responsible for all items of materials after receipt from the supplier, and shall replace all materials lost or damaged after delivery and receipt.

D. The Contractor shall furnish the materials supplier with receipts for all materials and accessory items received and shall send copies of these receipts to the Architect.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 UNIT HEATERS

A. General

1. All type heaters, as applicable, shall be hung with vibration spring isolators as hereinbefore specified.

2. The Contractor shall provide control valves and unit or remote mounted thermostats and wire to fan, to cycle fan “on/off.”

3. The Contractor shall make provisions to "open/close" the steam or water control valves when heaters are "on/off", as indicated hereinafter.

4. Unit manufacturer shall provide starters and disconnect switches.

5. Thermostats used with all type heaters shall be coordinated with the unit manufacturer for compatibility with equipment.

6. Heater colors, where applicable, shall be as provided as standard by the unit manufacturer.

7. Heater finish color shall be as determined by the Architect during shop drawings from the colors provided as standard by the unit manufacturer.

8. Temperature Control

a. Thermostat control shall be provided on floor and wall mounted units, consisting of factory built-in thermostat or wall-mounted thermostat of fully enclosed and snap acting to prevent radio or TV interference. The thermostat shall have a temperature adjustment range between 45°F and 95°F. Integral thermostats shall have tamperproof adjustment through the discharge grille by means of a hex wrench. Ceiling and inverted mounted units shall be provided with wall mounted MHT 4015E-1007 thermostat.

b. If not indicated on the plans the unit shall have a unit mounted return airside thermostat.

c. Thermostat shall operate the single-phase holding coil circuit of the integrally mounted power control relay(s). This single-phase relay holding coil circuit shall either be powered from the cabinet unit heater main power supply or from a separate 120V or 24V single-phase circuit.

d. An integral fan delay switch shall be provided to prevent discharge of cold air, by delaying start-up of the fan motor until heating elements have warmed up. This same fan delay switch shall maintain motor operation after heating elements have been de-energized to dissipate any residual heat.

e. Floor, wall and inverted mounted units shall be equipped as standard with a 2-speed/2-heat selector switch which will permit simultaneous tamperproof "high/low" adjustment of fan speed and heat output by means of a hex wrench through the discharge grille. Ceiling mounted units shall be wired for medium speed.

B. Electric propeller type unit heaters shall be as follows:

1. Provide electric unit heaters of the type, size, capacity and voltage as specified on the drawings.

2. Acceptable manufacturers subject to compliance with the specifications shall be as follows:

a. Qmark or approved equal.

3. Enclosures shall be fabricated from heavy gauge zinc coated steel, finished in high gloss beige enamel. Enclosures shall contain heating elements, contactors and control transformers where required. Air shall be drawn in the back of the heater and discharged through independently adjustable horizontal louvers on the front. In the low portion of the front, a large hinged access door extending the width of the heater shall be

provided for easy wiring and inspection of controls. Heater and supply wiring diagram shall be attached permanently to the inside of this door. Motor shall be mounted on a heavy gauge formed wire protective guard. A castle nut with cotter key shall be supplied on the top of the unit at center of gravity to allow easy support and adjustment.

4. Elements shall consist of helically coiled nickel chromium alloy resistance wire embedded and completely surrounded in magnesium oxide, enclosed and swaged into corrosion resistant sheaths to which are permanently attached corrosion resistant steel fins. Element assemblies shall be circular in shape and enclosed in a closely fitting cylinder creating a pressure chamber to assure uniform airflow.

5. Motors shall be totally enclosed industrial rated single-phase, permanently lubricated and equipped with thermal overload protection with automatic reset. Units rated 20 KW and less shall have shaded pole motors. Those over 20 KW shall have permanent split capacitor motors.

6. Fan blade shall be of the axial flow type designed for high efficiency and quiet operation. Fan speed shall not exceed 1700 rpm.

7. All heaters shall be equipped with a manual reset thermal cutout which disconnects elements and motors in the event normal operating temperatures are exceeded.

8. Heaters shall be designed for a single supply circuit, with elements, motor and control circuits subdivided and fused to conform to the National Electric Code, Occupational Safety and Health Act (OSHA) and Underwriters' Laboratories, Inc., Standard 573-1968. All 3-phase heaters shall have balanced phases.

9. Contactors and control circuit transformers, where required, shall be factory assembled and wired with only direct line supply and thermostat connections required in the field.

10. Heaters are to be listed under the Re-Examination Service of Underwriters' Laboratories, Inc. Heaters shall be guaranteed to be free from defective material and workmanship for a period of one (1) year, with the exception of the heating elements which shall be guaranteed for five (5) years.

C. Gas Fired

1. Propeller and centrifugal fan gas fired unit heaters shall be of the size and capacity as scheduled.

a. Acceptable manufacturers subject to compliance with the specifications shall be as follows:
   1) Reznor or approved equal.

2. Units shall be completely factory assembled, piped, wired and test fired. All units shall be AGA Certified and conform with the latest ANSI Standards for safe and efficient performance. Units provided with two-point suspension hangers on propeller fan unit heaters and with four-point suspension hangers on centrifugal fan unit heaters.

3. Casings shall be die-formed, 20-gauge galvanized steel and finished in baked enamel. The bottom panel shall be removable to provide service access to the burners, pilot and orifices. The pilot shall also be accessible through a side panel access plate. All units shall be provided with independently adjustable horizontal louvers with stops to prevent total closure.

4. Heat exchangers shall be constructed of seam welded 20-gauge aluminized steel tubes and 18-gauge aluminized steel headers.

   a. The heat exchanger, burner and draft hood assembly shall carry a non-prorated warranty to be free from defective material and workmanship for a period of ten (10) years from date of manufacture, excluding loss due to misuse, negligence, or corrosion by chemicals precipitated in the air.

   b. Burners shall be die-formed, corrosion resistant aluminized steel, with stainless steel port protectors. Burners shall be individually removable for ease of inspection and servicing with an individually adjustable, manually rotated air shutter adjustment.

   c. Fan blades shall be constructed of aluminum with an aerodynamic contour. All fans are to be dynamically balanced for quiet, efficient operation and supplied with a protective type fan guard. Rubber-in-shear isolators shall provide isolation between the fan/motor combination and the unit heater casing.

   d. All motors shall be totally enclosed with built-in thermal overload protection and permanently lubricated bearings.

   e. A factory-installed junction box shall be provided for all power connections. Units shall be provided with a 24-volt combination single stage redundant gas valve, consisting of a combination pilot solenoid valve, automatic electric gas valve, pilot filter, pressure regulator, pilot adjustment and manual shutoff. A flue vent fan relay and combustion air proving switch shall also be provided.

Standard equipment shall include spark-ignited intermittent pilot system with electronic flame supervision. A 24-volt control transformer, high limit and fan time delay relay shall be provided. The fan time delay relay delays the fan start until the heat exchanger reaches a predetermined temperature. It also allows the fan to operate after burner shutdown, removing residual heat from the heat exchanger.

f. Two-state gas valve shall be provided with two stages of heat. Ignition is at low fire (50% of the furnaces rated input) and requires the use of a two-stage thermostat. This thermostat shall be provided as part of the gas fired unit heater and shall be wired to control the burner unit by the ATC Contractor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install equipment exposed to finished area after walls and ceiling are finished and painted. Do not damage equipment or finishes.

C. Protection: Provide finished cabinet units with protective covers during balance of construction.

D. Radiation: Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Install end caps where units butt against walls or have exposed ends. Align cabinet joints with window mullions. Install wall angles where units butt against walls.

E. Unit Heaters: Hang from building structure and not from piping, with gas pipe hangers anchored. Mounts as high as possible to maintain greatest headroom unless otherwise indicated.

F. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's submittals and Section 260520.

3.02 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filters at all cabinet unit heaters prior to completion of the project.

END OF SECTION 238235

SECTION 238240 – DX MINI-SPLITS SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section 230500 also applies to this Section.

1.2 WORK INCLUDED

A. Furnish and install all terminal heat transfer units of the type, size and capacity as scheduled.

B. Units shall be UL and AGA listed in accordance with the specific unit’s heat transfer design and construction.

1.3 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

1.4 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as following:

1. UL 1025-89 – Electric Air Heaters.

2. UL 1042-86 – Electric Baseboard Heating Equipment.

3. ASHRAE 90.1 – Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.

4. NFPA 54 – National Fuel Gas Code.

5. NFPA 90A – Installation of Air Conditioning and Ventilating Systems.

6. NFPA 90B – Installation of Warm Air Heating and Air Conditioning Systems.

7. NFPA 211 – Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances.

1.5 SYSTEM DESCRIPTION

A. Furnish and install all radiation, unit heaters, radiant panels, controls, piping, wiring, enclosures, access doors, etc. to make a complete and operational system.

B. All enclosures shall be installed with aligning strips, plaster frames and end trims so as to provide a neat architectural finish.

C. All equipment shall be new and shall be of the type, style, size and capacities as scheduled. All radiation enclosures shall be continuous and of the same finish and style as adjacent enclosures.

1.6 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. Product Data: Provide typical catalog of information including arrangements.

D. Shop Drawings:

1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers and comparison of specified heat required to actual heat output provided.

a. Indicate cross sections of cabinets, grilles, bracing and reinforcing, mounting details and insulation if required and typical elevations.

b. Indicate flows, pressure drops (including interconnecting piping for radiant panels), heat outputs and mean temperatures.

c. Indicate mechanical and electrical service locations and requirements.

E. Manufacturer's Instructions: Indicate installation instructions and recommendations.

F. Project specific installation instructions and details.

G. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets and ceiling panels required for access or valving.

H. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listings.

I. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.8 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years of documented experience.

C. Products Requiring Electrical Connection: Listed and classified by Underwriter's Laboratories Inc. testing firm acceptable to the authority having jurisdiction and suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Delivery of materials shall be made to the project by the materials supplier in accordance with the instructions to the Contractor.

C. The Contractor shall provide adequate locked storage space with shelving for the materials, shall be responsible for all items of materials after receipt from the supplier, and shall replace all materials lost or damaged after delivery and receipt.

D. The Contractor shall furnish the materials supplier with receipts for all materials and accessory items received and shall send copies of these receipts to the Architect.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 ACCEPTABLE MANUFACTURERS

A. Mitsubishi-Multi City

2.3 SYSTEM DESCRIPTION

A. The heat pump air conditioning system shall be similar to model PKA manufactured by Mitsubishi Electric System.

2.4 QUALITY ASSURANCE

A. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

2.5 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendation.

2.6 WARRANTY

A. The units shall be covered by the manufacturer's limited warranty for a period of three (3) year from date of installation.

B. Control:

1. Each indoor unit shall be provided with a digital, wireless, remote controller to perform all input functions necessary to operate the system.

2. The indoor unit shall have the option of a field installed hard-wired digital remote controller.

3. The remote controller shall provide a Power On/Off switch, Mode Selector – Cool-Dry-Heat, Temperature Setting, 24 Hour Clock / Timer Control, Fan Speed Select and Auto Vane selector.

4. Operating mode for all units in the multi-zone system shall be determined by the first indoor unit to request Heat or Cool function.

5. The indoor unit shall perform Self-diagnostic Function and be equipped with Test Run switching and Check Mode switching.

6. Temperature changes shall be by 1ºF increments with a range of 61-88ºF.

7. The microprocessor located in the indoor unit shall have the capability of sensing return air temperature and indoor coil temperature, receiving and processing commands from the wireless or wired digital remote controller, providing emergency operation and controlling the outdoor unit.

8. The indoor units shall be capable of working with both single-zone or multi-zone outdoor units

9. The system shall be capable of automatically restarting, at all previous settings, when the power is restored after power interruption.

10. The digital remote controller shall control the operation of the motorized, vertical, air sweep louver for Auto (position determined by control program), Manual (four controller selectable positions) or Sweep (continuous motion). The louver shall drive to the closed position when the indoor unit is turned off.

PART 3 - DESIGN (See drawings for applicable model number)

3.01 UNIT CABINET

A. The indoor unit cabinet shall be wall mounted by means of a factory supplied mounting plate, The cabinet shall be formed from high strength molded plastic with front panel access for filter. Cabinet color shall be white.

B. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor.

C. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

3.02 FAN

A. The evaporator fan shall be high performance, double inlet, forward curve, direct drive sirocco fan with a single motor – One for 12,000 and 18,000 and 2 for 24,000, 30,000, and 36,000 The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall have four (4) speeds for 12,000 and 18000: Low, M1, M2, and High and two (2) speeds for 24,000, 30,000, and 36,000: Low, High.

3.03 VANE

A. There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower noise levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.

3.04 FILTER

A. Return air shall be filtered by means of an easily removable washable filter.

3.05 COIL

A. The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

3.06 ELECTRICAL

A. The electrical power of the unit shall be as scheduled. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit, using the Mitsubishi Electric A-Control system. For A-Control, a three (3) conductor AWG-14 wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units.

3.07 CONTROL

A. The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit. Field wiring shall run directly from the indoor unit interconnected by a single non-polar two-wire AWG-16 stranded cable to the wall mounted controller with no splices. The control system between the outdoor unit and indoor unit shall be supplied from the outdoor unit using the Mitsubishi Electric A-Control system.

B. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

C. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.

D. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD) presenting contents in eight (8) different languages. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F.

E. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.

F. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,500 feet (500 meters).

G. The control voltage from the wired controller to the indoor unit shall be 12 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.

H. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

PART 4 - OUTDOOR UNIT

4.01 GENERAL

A. The outdoor unit shall be compatible with the three different types of indoor units (PKA - wall mounted, PCA - ceiling suspending, and PLA - four way ceiling cassette). See drawings for exact model number. The connected indoor unit must be of the same capacity as the outdoor unit. Models PUY-A24NHA and PUY-A36NHA shall have the option to connect to two indoor units, within the same confined space, to improve air distribution (total capacity shall be equivalent to outdoor unit). The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.

B. The outdoor unit shall be capable of operating at 0°F (-18°C) ambient temperature without additional low ambient controls (optional wind baffle may be required).

C. The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) indoor unit to outdoor unit,

D. System shall have a maximum refrigerant tubing length of 100 feet (30 meters) for the 12,000 and 18,000 and 165 feet (50 meters) for the 24,000, 30,000 and 36,000 between indoor and outdoor units without the need for line size changes, traps or additional oil.

E. Models PUY-A12NHA, PUY-A18NHA, PUY-A24NHA, PUY-A30NHA and PUY-A36NHA shall be pre-charged for a maximum of 70 feet (20 meters) of refrigerant tubing. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.

4.02 CABINET

A. The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a munsell 3Y 7.8/1.1 finish. The fan grille shall be of ABS plastic.

4.03 FAN

A. Models PUY-A12NHA, PUY-A18NHA, PUY-A24NHA, PUY-A30NHA, and PUY-A36NHA shall be furnished with an AC fan motor. The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear

and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.

4.04 COIL

A. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.

4.05 COMPRESSOR

A. The compressor for models PUY-A12NHA, PUY-A18NHA, PUY-A24NHA, PUY-A30NHA and PUY-A36NHA shall be a DC rotary compressor with Variable Compressor Speed Inverter Technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

4.06 ELECTRICAL

A. The electrical power of the unit shall be 208volts or 230 volts, 1 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The outdoor unit shall be controlled by the microprocessor located in the indoor unit.

B. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

END OF SECTION 238240

SECTION 238316 – HYDRONIC SNOW MELT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Under the requirements of this Section, provide a complete snow melt system for the Station platforms, stairs and ramps including, but not limited to: boilers, circulating pumps, distribution and heating piping, expansion tanks, air separators, air vents, relief valves, control valves, shut-off valves, gauges, flow indicators, sensors, and snow melting control system. It is the intent that a complete and fully operational snow melt system be provided under this Section.

B. Design Requirements

1. Standard Grade hydrostatic pressure ratings from Plastics Pipe Institute in accordance with TR-4/03. The following three Standard Grade ratings are required.

    a. 200 degrees F at 80 psi
    b. 180 degrees F at 100 psi
    c. 73.4 degrees F at 160 psi

2. Certification of flame spread/smoke development rating of 25/50 in accordance with ASTM E84 for the following PEX tubing sizes.

    a. 5/16 inch
    b. 3/8 inch
    c. 1/2 inch
    d. 5/8 inch

e. 3/4 inch

C. Performance Requirements:
1. Provide hydronic radiant floor heating system that is manufactured, fabricated and installed to comply with regulatory agencies and authorities with jurisdiction, and maintain performance criteria stated by the PEX tubing manufacturer without defects, damage or failure.
2. Comply with ASTM F877.
3. Comply with DIN 4726 regarding oxygen diffusion concerns.
4. Comply with ASTM E119 and ANSI/UL 263.

a. UL Design No. L557 - 1 hour wood frame floor/ceiling assemblies
b. UL Design No. K913 - 2 hour concrete floor/ceiling assemblies

D. UL Design No. V444 - 1 hour steel stud/gypsum wallboard wall assemblies

E. This Section includes radiant heating system, including pipes, fittings, and piping specialties.

1.3 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

1. ASTM International

a. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials

b. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials

c. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops

d. ASTM F876 Standard Specification for Crosslinked Polyethylene (PEX) Tubing

e. ASTM F877 Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water

2. Distribution Systems

    a. ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing

3. American National Standards Institute (ANSI)/Underwriters Laboratories, Inc. (UL)

    a. ANSI/UL 263 Standard for Safety for Fire Tests of Building Construction and Materials

4. Canadian Standards Association (CSA)

    a. CAN/CSA B137.5 Cross-Linked Polyethylene (PEX) Tubing Systems for Pressure Applications

5. German Institute for Standards (Deutsches Institut fur Normung e.V., DIN)

    a. DIN 4726 Pipelines of Plastic Materials Used in Warm Water Floor Heating Systems; General Requirements

6. International Conference of Building Officials (ICBO) Evaluation Services

    a. Evaluation Report No. 4407
    b. Evaluation Report No. 5143

7. International Code Council (ICC)

8. International Mechanical Code (IMC), 2003

9. International Energy Conservation Code (IECC), 2009

10. Plastics Pipe Institute (PPI)

    a. Technical Report TR-3 Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials
    b. Technical Report TR-4 Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Piping and Fitting Compounds

11. Viega

a. Complete Design Assistance Manual (CDAM), current edition
b. Radiant Floor Installation Handbook, current edition
c. Design Software

B. Related Sections include the following:

1. Section 230584 “Firestopping”.
2. Section 230500 “Basic Mechanical Materials and Methods”.
3. Section 220553 “Identification for Plumbing Piping and Equipment”.
4. Section 232123 “Hydronic Pumps”.
5. Section 235224 “Condensing Boilers”.

1.4 DEFINITIONS

A. PEX: Crosslinked polyethylene.

B. PEX-AL-PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.

1.5 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.

C. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, snow and ice detection system, and support assemblies and their attachments to the building structure.

D. Calculations Reports; Show output of the heating/cooling system to include any excess or shortages of heating or cooling, heating/cooling entering the space, flow rates, head loss, back losses of heating/cooling, floor covering resistance, and floor surface temperatures.

E. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

F. Quality Assurance/Control Submittals: Submit the following:

1. Test Reports: Upon request, submit test reports from recognized testing laboratories.
2. Documentation: Submit the following:

a. Manufacturer's certificate indicating products comply with specified requirements.
b. Manufacturer's detailed room-by-room heat-loss analysis for the structure.
c. Documentation indicating the installer is trained to install the manufacturer's products.

G. Maintenance Data: For manifolds and control devices to include in maintenance manuals specified in Division 1 Section "Operation and Maintenance Data."

1.6 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Installer Qualifications: Use an installer with demonstrated experience on projects of similar size and complexity and possessing documentation proving successful completion of radiant floor heating training by the PEX tubing manufacturer.

C. Regulatory Requirements and Approvals: Provide radiant floor heating system that complies with the following Requirements.

1. International Building Code (IBC), 2003
2. International Energy Conservation Code (IECC), 2009
3. International Mechanical Code (IMC), 2003

a. ICBO Evaluation Service Evaluation Report No. 4407
b. ICBO Evaluation Service Evaluation Report No. 5143

4. Building Officials and Code Administrators International (BOCA)

   a. BOCA National Building Code

5. Southern Building Code Congress International (SBCCI)

   a. Standard Mechanical Code

6. Uniform Mechanical Code (UMC)

D. Certifications: Provide letters of certification as follows.

1. Installer is trained by the PEX tubing manufacturer to install the radiant floor heating system.
2. Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed trades person.

E. Pre-installation Meetings.

1. Verify project requirements, substrate conditions, floor coverings, manufacturer's installation instructions and warranty requirements.

2. Review project construction timeline to ensure compliance or discuss modifications as required.

3. Interface with other trade representatives to verify areas of responsibility.

4. Establish the frequency and construction phrase the project engineer intends for site visits and inspections by the PEX tubing manufacturer's representative.

F. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

G. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.8 COORDINATION

A. Coordinate layout and installation of radiant heating piping and support/suspension system with building and structural components.

B. Coordinate layout and installation of radiant heating piping and support/suspension system with other systems including, but not limited to: light fixtures, HVAC equipment, water distribution piping, and electrical distribution.

C. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section “Firestopping” for fire and smoke wall and floor assemblies.

D. Coordinate size and location of access panels to allow access to manifolds concealed in ceilings, walls, and floors.

E. Coordinate thickening of slabs where required for adequate encasement of radiant heating piping components.

F. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Engineer.

1.9 DELIVERY, STORAGE & HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. General: Comply with Division 1 Product Requirement Section.

C. Comply with manufacturer’s ordering instructions and lead-time requirements to avoid construction delays.

D. Delivery: Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.

E. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

1. Store PEX tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.

2. Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing that is exposed to direct sunlight.

1.10 OWNER'S INSTRUCTIONS

A. Instruct Owner's personnel about operation and maintenance of installed system. Provide manufacturer's installation, operation and maintenance instructions for installed components within the system.

1.11 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Manufacturer warranty shall include the following:
   1. In the event that manufacturer determines that the failure or leak and any resulting damages were the result of a manufacturing defect in the products covered by the warranty and occurred during the first ten years of the time period covered by the warranty, the manufacturer will reimburse the property owner for reasonable repair or replacement charges resulting from the failure or leak and, additionally will reimburse damages to personal property resulting from the failure or leak.
   2. Radiant heat pipe manufacturer shall warranty the tubing under normal conditions of use and properly maintained, will be free from failure caused by manufacturing defect for a period of thirty (30) years from date of installation, when properly installed by contractors trained by manufacturer.
   3. PEX Press fittings will be free from failure caused by manufacturing defect for a period of thirty (30) years from date of installation.
   4. Manifolds shall be free from manufacturing defect for a period of five (5) years.
   5. Controls and electrical components shall be free from manufacturing defect for a period of two (2) years from date of installation.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Pipes and Fittings:
   a. For 1 ½ and smaller Viega and for 2" and up Uponor, LLC or approved equal.
2. Distribution Manifolds:
   a. Viega, LLC or approved equal.
3. Controls:
   a. Tekmar Control Systems, Ltd or approved equal.
4. Calibrated Balancing Valves:
   a. Armstrong Pumps, Inc or approved equal.
5. Pressure-Reducing Valves:
   a. Amtrol, Inc. or approved equal.
6. Safety Valves:
   a. Amtrol, Inc. or approved equal.
7. Automatic Flow-Control Valves:
   a. Flow Design, Inc or approved equal.
8. Expansion Tanks:
   a. Amtrol, Inc. or approved equal.
9. Air Separators and Air Purgers:
   a. Amtrol, Inc. or approved equal.

2.3 PIPES AND FITTINGS

A. Refer to Part 3 "Piping Applications" Article for applications of piping type.

2.4 PEX PIPES AND FITTINGS

A. Pipe Material:
1. PEX tubing shall be silane cross-linked high density polyethylene as per ASTM F876/F877 and CSA B137.5.
2. Tubing includes four layers:
   a. First layer: Cross-linked, high density polyethylene.
   b. Second layer: Adhesive.
   c. Third layer: Ethylene vinyl alcohol layer (EVOH oxygen barrier).
   d. Fourth layer: Polyethylene to protect the EVOH layer from damage.
3. Certified to NSF 14 and 61.
4. Tubing will have 6 month UV protection.

B. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

C. Zero Lead Bronze Fittings: PEX Press Fittings manufactured from UNS C87700 copper alloy, meeting the requirements of ASTM F 877 tested as a system with PEX tubing.
   1. Press Sleeve: Manufactured out of a 304 grade or better stainless steel, and have view hole to ensure proper PEX tubing insertion.
   2. Press connection shall be made with a manufacturer supplied ratcheting press hand tool or press power tool.
   3. Unpressed connections are located by pressurizing the system to 0.5 PSI to 100 PSI.

D. Polymer Fittings: PEX Press Fittings manufactured from Radel-R® polymer, meeting the requirements of ASTM F 877 tested as a system with PEX tubing.
   1. Press sleeve: manufactured out of a 304 grade or better stainless steel and have view hole to ensure proper PEX tubing insertion.
   2. Press connection shall be made with a manufacturer supplied ratcheting press hand tool or press power tool.
   3. Unpressed connections are located by pressurizing the system to 0.5 PSI to 100 PSI.

E. Pressure/Temperature Rating: PEX tubing shall meet the standard grade hydrostatic pressure ratings from the Plastic Pipe Institute in accordance with TR-4/03. The following three ratings are required:
   1. 200 deg F at 80 psi.
   2. 180 deg F at 100 psi.
   3. 73.4 deg F at 160 psi.

2.5 PEX-AL-PEX PIPES AND FITTINGS

A. Pipe Material:
   1. PEX-AL-PEX tubing shall be silane cross-linked high density polyethylene bonded to the inside and outside of a welded aluminum tube as per ASTM F1281.
   2. Certified to NSF 14 and 61.
   3. Tubing will have 6 month UV protection.

B. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

C. Zero Lead Bronze Fittings: Press Fittings manufactured from UNS C87700 copper alloy, meeting the requirements of ASTM F 877 tested as a system with PEX-AL-PEX tubing.
   1. Press Sleeve: Manufactured out of a 304 grade or better stainless steel, and have view hole to ensure proper PEX-AL-PEX tubing insertion.

2. Press connection shall be made with a manufacturer supplied ratcheting PEX Press hand tool or press power tool.
3. Unpressed connections are located by pressurizing the system to 0.5 PSI to 100 PSI.

D. Polymer Fittings: Press Fittings manufactured from Radel-R® polymer, meeting the requirements of ASTM F 877 tested as a system with PEX-AL-PEX tubing.
1. Press sleeve: manufactured out of a 304 grade or better stainless steel and have view hole to ensure proper PEX-AL-PEX tubing insertion.
2. Press connection shall be made with a manufacturer supplied ratcheting press hand tool or press power tool.
3. Unpressed connections are located by pressurizing the system to 0.5 PSI to 100 PSI.

E. Pressure/Temperature Rating: PEX-AL-PEX tubing shall meet the standard grade hydrostatic pressure ratings from the Plastic Pipe Institute in accordance with TR-4/03. The following three ratings are required:
1. 200 deg F at 80 psi.
2. 180 deg F at 100 psi.
3. 73.4 deg F at 160 psi.

2.6 COPPER PIPES AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B88, Type K.

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

E. Solder Filler Metals: ASTM B32, 95-5 tin antimony.

F. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.7 STEEL PIPES AND FITTINGS

A. Steel Pipe, NPS 2 and Smaller: ASTM A53, Type S (seamless) or Type E (electric resistance welded), Grade B, Schedule 40, black steel, plain ends. Pipe joints shall be threaded in accordance with ANSI/ASME B1.20.1 (interior & exterior).

B. Steel Pipe, NPS 2-1/2 through NPS 12: ASTM A53, Type E (electric-resistance welded), or Type S (Seamless) Grade B, Schedule 40, black steel, plain ends. Pipe joints shall be beveled and butt welded (interior & exterior).

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A234, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

I. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.8 DISTRIBUTION MANIFOLDS

A. Stainless Manifold with Balancing and Main Shut-off Valves: Minimum NPS 1 1/4 (DN 32).

B. Manifolds shall be made of 304 Stainless Steel.

C. Balancing valves and shut-off valves are integrated on manifold.

D. Air bleeders and purge valves are to be integrated on manifold.

E. Manifolds have 1 in NPT removable end caps and 1 1/4 in NPT Union connections.

F. Use bracket supplied by manufacturer to mount manifold.

G. Select and size manifold box based on manifolds, accessories and fittings added.

H. Maximum Operating Pressure: 100 psi

I. Maximum Operating Temperature: 180 deg F Balancing Valves for Manifolds:
   1. Body: Brass, nickel plated.
   2. Valve Spindle: Brass, EPDM.

3. Inlet Connection: NPS 1/2 (DN 15), 1/2 inch with o-ring.
4. Operator: Allen Wrench -
5. CWP Rating: 145 psi .
6. Maximum Operating Pressure: 100 psi .
7. Maximum Operating Temperature: 180 deg F.

J. Main Shut-off Valves for Manifolds:
1. Field installed on supply and return connections.
2. Two-piece body.
3. Body: Brass nickel-plated body.
4. Ball: Full port chrome-plated brass.
5. Seals : PTFE.
6. Stem: Brass with 2 Buna-N o-rings and blowout proof assembly.
7. CWP Rating: 100 psig
8. Maximum Operating Temperature: 180 deg F

2.9 CONTROLS

A. Control System: Microprocessor-based automatic control with manual override. Automatically detects snow/ice and maintains set temperature in a heating panel. Features shall include:
1. LCD to view system status and operating information.
2. Remote display and control capabilities
3. Boiler protection
4. Test sequence to ensure proper component operation
5. CSA C US Certified (approved to applicable UL standards)

B. Snow and ice sensors shall sense the surface conditions and slab temperature of heated surface and shall be programmed to operate pumps as follows:
1. Temperature Span: 32 to 95 deg F.
2. Idling Temperature Span: 20 to 95 deg F.
3. Cold Weather Cut Out Span: -29 to 50 deg F.
4. Start pump if ambient temperature is below set point and snow/ice is detected.
5. Start pump if ambient temperature is below set point and snow/ice is not detected and system is intended to idle.
6. Stop pump on detection of a dry surface plus time delay.
7. Stop pump on detection of Cold Weather Cut Out Temperature.

C. Minimum 5-A contactor to start pumps.

D. Snow/ice sensors shall be mounted in heated surface at location indicated on drawings.

2.10 VALVES

A. Gate, check, ball, and butterfly valves are specified in Division 22 Section “Facility Water Distribution”

B. Refer to Part 3 “Valve Applications” Article for applications of each valve.

C. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 ºF maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

D. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 ºF maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

E. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

F. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

G. Automatic Flow-Control Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Valve shall be line size and one of the following designs:

1. Gray-iron or brass body, designed for 175 psig at 200 ºF with stainless-steel piston and spring.
2. Brass or ferrous-metal body, designed for 300 psig at 250 ºF with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig at 250 ºF.

2.11 HYDRONIC SPECIALITIES

A. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 ºF operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.

B. Diaphragm Type Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 ºF maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible diaphragm securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

C. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 ºF maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.

D. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300 ºF.

E. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250 ºF.

F. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

G. Diverting Fittings: 125-psig working pressure; 250 ºF maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.

H. Y-Pattern Strainers: 175-psig working pressure; cast-iron body (ASTM A126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.

2.12 FLOW METERS

A. Orifice principle by-pass circuit with direct reading gage, soldered or flanged piping connections for 125 psig working pressure, with shut off valves, and drain and vent connections.

B. Direct reading with insert pitot tube, threaded coupling, for 150 psig working pressure, maximum 240 ºF, 5 percent accuracy.

C. Cast iron, wafer type, orifice insert flow meter for 250 psig working pressure, with read out valves equipped with integral check valves with gasketed caps.

D. Calibrated, plug type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer.

E. Cast iron or bronze, globe style, balance valve with handwheel with vernier type ring setting and memory stop, drain connection, readout valves equipped with integral check valves and gasketed caps.

2.13 PRODUCT SUBSTITUTIONS

A. All products, components, etc., specified herein are manufactured by and/or available from the PEX tubing manufacturer.

B. Alternative equipment manufacturers must submit required data for all electrical, mechanical, structural, engineering, etc. revisions for an equivalent system for approval 15 days prior to bid.

C. Alternative equipment manufacturers must submit completed radiant floor design layout to the project engineer for approval. Plagiarism of another manufacturer’s design is unacceptable.

2.14 PIPING SPECIALITIES

A. Cable Ties:
1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 0.17 inch
3. Tensile Strength: 75 lb, minimum.

B. Floor Mounting Staples:
1. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 0.055 inch.
3. Width: 0.962 inch.

C. Floor Mounting Clamps:
1. Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch.

3. Width: Minimum, wider than tubing.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Aboveground and Interior:
   1. Hot Water Glycol, NPS 2 and Smaller: use Type L drawn-temper copper tubing with soldered joints.
   2. Hot Water Glycol, NPS 2-1/2 to NPS 12: use Schedule 40 steel pipe with beveled end butt welded joints.

B. Belowground and Concrete Encased:
   1. Hot Water Glycol, NPS 1 and Smaller: use PEX-AL-PEX and compatible fittings.
   2. Hot Water Glycol, NPS 1-1/2 and Larger: use PEX and compatible fittings.

3.2 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

B. Shutoff Duty: Gate, ball, and butterfly valves.

C. Throttling Duty: Globe, ball, and butterfly valves.

D. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

E. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

F. Install check valves at each pump discharge and elsewhere as required to control flow direction.

G. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

H. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.3 EXAMINATION

A. Examine surfaces and substrates to receive radiant-heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
   1. Ensure that surfaces and pipes in contact with radiant-heating piping are free of burrs and sharp protrusions.
   2. Ensure that surfaces and substrates are level and plumb.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING INSTALLATION

A. Refer to manufacturer's most current installation instructions.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings or coordination drawings.

C. Piping in Snow melt Equipment Rooms:
   1. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
   2. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
   3. Install piping at a uniform grade of 0.2 percent upward in direction of flow except as noted otherwise.
   4. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
   5. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
   6. Provide manual air vents at system high points and as required.
   7. Provide air separator on suction side of system circulation pump and connect to expansion tank.
   8. Provide relief valves on pressure tanks and expansion tanks.
   9. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple

and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

10. Anchor piping for proper direction of expansion and contraction.

D. Piping in Exterior Concrete:
   1. Install radiant-heating piping at least 4 inches from edge of slabs, walls or other permanent objects.
   2. Maintain 2-inch minimum cover.
   3. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels. All joints in radiant-heating piping shall be within manifolds boxes.
   4. Avoid crossing radiant-heating piping in topping unless minimum concrete cover of 2 inches is met.
   5. Square off radiant-heating piping with approved PEX Cutters.
   6. Connect radiant-heating piping to manifold using approved manifold adapters.
   7. Use bend supports for pipe entering and exiting the slab.
   8. Do not bend pipe in radii smaller than manufacturer's minimum bend radius.
   9. Manifolds should be installed with brackets supplied by manufacturer.
   10. Secure piping by attaching pipes to reinforcement using approved fasteners from manufacturer.
   11. Space fasteners a maximum of 24 inches o.c. and at center of turns and bends.
   12. Install a sleeve of 3/8-inch thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 6 inches on each side of plank expansion joints to protect the tubing passing through expansion joints. Anchor sleeve to slab form at expansion joints to provide maximum clearance for saw cut.
   13. Maintain pressure test of a minimum 100 psig to 1.5 times system working pressure.
   14. After initial pressurization, ensure pressure has not dropped after 20 minutes. Fluctuations may occur due to temperature fluctuations and tubing expansion. If a drop has occurred add pressure to the system. Carry out testing for a minimum of 1 hour.
   15. Maintain pressure in piping during concrete installation and continue for 24 hours after placement.

E. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Engineer.

F. Fill system with 40 percent of propylene glycol-to-water solution:
   1. Clean and passivate new glycol systems.
   2. Add corrosion inhibitor to glycol solution.
   3. All chemicals must be consistent with PEX and/or polyethylene tubing.

G. After system balancing has been completed, mark balancing valves to permanently indicate final position per design.

H. Perform the following adjustments before operating the system:

1. Open valves to fully open position.
2. Purge air from piping.

I. After concrete heating panel has cured as recommended by concrete supplier, operate radiant-heating system as follows:

1. Start warm up after concrete has reached its final set (curing complete).
2. Set supply water temperature to 77 deg F for the first three days.
3. Increase supply water temperature to the set point in gradual increments for the next 4 days. Maximum of a 20 deg F increase in a period of 24 hour.
4. For freeze protection, operate at a minimum of 60 deg F supply-water temperature or provide adequate antifreeze protection.

3.5 FIELD QUALITY CONTROL

A. Prepare radiant heating piping for testing as follows:

1. Temporarily restrain expansion joints so they are not damaged due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
2. Flush with clean water, and clean strainers.
3. Install relief valve set at a pressure no more than one-third higher than test pressure.

3.6 TESTING AND BALANCING

A. Hydrostatic (Leak) Test:

1. Perform the following tests and inspections with the assistance of a factory-authorized service representative prior to concrete encasement
2. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Eliminate leaks by tightening, repairing or replacing components and repeat hydrostatic test until there are no leaks.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Radiant-heating piping will be considered defective if it does not pass hydrostatic tests and inspections.

B. General Procedures for Hydronic Systems:

1. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
2. Prepare schematic diagrams of systems' "as-built" piping layouts.
3. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
    a. Open all manual valves for maximum flow.
    b. Check expansion tank liquid level.
    c. Check makeup-water-station pressure gage for adequate pressure for highest vent.
    d. Check flow-control valves for specified sequence of operation and set at indicated flow.
    e. Set differential-pressure control valves at the specified differential pressure.
    f. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
    g. Check air vents for a forceful liquid flow exiting from vents when manually operated.

C. Test Procedures for Hydronic Systems:

1. Measure water flow at pumps. Use the following procedures:
    a. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    b. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
    c. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
    d. Report flow rates that are not within plus or minus 5 percent of design.
2. Set calibrated balancing valves, if installed, at calculated presettings.
3. Measure flow at all stations and adjust, where necessary, to obtain first balance.
    a. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
4. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

5. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
    a. Determine the balancing station with the highest percentage over indicated flow.
    b. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
    c. Record settings and mark balancing devices.
6. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
7. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

D. Procedures for Motors:

1. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
    a. Manufacturer, model, and serial numbers.
    b. Motor horsepower rating.
    c. Motor rpm.
    d. Efficiency rating.
    e. Nameplate and measured voltage, each phase.
    f. Nameplate and measured amperage, each phase.
    g. Starter thermal-protection-element rating.

E. Prepare test and inspection reports.

3.7 CLEANING

A. After testing has been successfully completed, flush piping and clean strainer screens.

END OF SECTION 238316

SECTION 251000 – DIRECT DIGITAL/AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section 250500 also applies to this Section.

1.02 WORK INCLUDED

A. Furnish and a complete system of automatic temperature controls to make a fully operational and controllable building HVAC system.

B. The system and sequence of operation shall comply with International Energy Conservation Code (IECC), 2009.

C. The system shall be all electric DDC (direct digital control).

D. All system components shall be installed in accordance with local and State codes.

E. Secure all permits and local/State approval for all components and installation as specified under this Section.

F. Provide complete commissioning for all control system components and sequences of operation.

G. Preparation and submission of shop drawings.

1.03 RELATED SECTIONS

A. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.

B. Division 21

C. Division 22

D. Division 23

E. Division 25

F. Division 26

1.04 REFERENCES

A. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work of this Section, and are hereby incorporated into, and made a part of the Contract Documents.

B. Material standards shall be as specified or detailed hereinafter and as follows:

1. NFPA 70 – National Electric Code.

2. UL-916 – Energy Management Systems.

3. UL-873 – Temperature Indication and Regulating Equipment.

4. FCC; Part 15, Subpart J – Class A computing Equipment.

5. UL-864 – Fire and Smoke Control.

1.05 SYSTEM DESCRIPTION

A. Furnish and install, as hereinafter specified, a combination direct digital/ electric/electronic temperature control system and Building Automation System (BAS). The system shall be comprised of a network of various independent Stand-alone Digital Controllers, electric/electronic control equipment, thermostats, sensors, controllers, valves, dampers, actuators, panels and related hardware, software and other accessory equipment, along with a complete system of electrical control wiring, and software generation to fill the intent of the specifications and provide for a complete and operable system.

B. The control systems shall be installed by competent control mechanics and electricians regularly employed by the manufacturer of the control equipment. All control equipment shall be the product of one (1) manufacturer and all components shall be capable of interfacing with the HVAC equipment. The factory trained Contractor must maintain adequate staff and offer standard services to fully support the owner in the timely maintenance, repair, and

operation of the control system. Contractors who do not maintain such staff and offer services or must develop some for this project are not acceptable.

C. Bids from franchised dealers or others whose principal business is not the manufacture, installation and service of temperature control systems will not be acceptable.

D. The Contractor shall submit a copy of the manufacturer's standard software and firmware licensing agreement for the owner's signature. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets constrained within such software.

E. All products of the Building Automation System shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products shall be provided. Systems or products not currently offering the following approvals are not acceptable.

1. UL-916; Energy Management Systems

2. UL-873; Temperature Indication and Regulating Equipment UL-864; Subcategories UUKL, QVAX, UDTZ; Fire and Smoke Control Systems

3. FCC; Part 15, Subpart J, Class A Computing Devices

F. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National Codes.

1.06 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. See Section 230500 for additional requirements.

C. Product Data: Provide data for each system component and software module.

D. Shop Drawings.

1. Indicate trunk cable schematic showing programmable control unit locations and trunk data conductors.

2. List connected data points, including connected control unit and input device.

3. Indicate all system graphics for all controlled systems including all air handling systems, hydronic pumping systems, monitored systems, data (connected and calculated) point addresses and operator notations.

4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems and interconnections.

5. Indicate description and sequence of operation of operating, user and application software

6. Show electronic ranges for each valve, damper, inlet vanes actuators etc., (i.e. 8-13 psi or 0-10 vdc).

7. Show system network architecture with high level and lower level transmission and communications network to include all addressable controllers, communication repeaters, routers, gateways, operator workstations, terminal connection ports, network servers, printers, etc.

8. All control logic and controllable components shall be depicted and identified within each matrices developed.

9. All UUKL components shall be depicted and identified.

E. Manufacturer's Installation Instructions: Indicate manufacturer's installation instructions for all manufactured components.

F. Submit brochures that contain only that information which is relative to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless irrelevant information is marked out and relevant material is clearly marked.

G. Specifications Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with the specifications.

2. The statement of compliance shall consist of a list of all paragraphs (line by line).

3. Where the proposed system complies fully, such shall be indicated by placing the word "comply: opposite the paragraph number.

4. Where the proposed system does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.

5. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question.

6. Submissions which do not include a point by point statement of compliance as specified shall be disqualified.

H. Project Record Documents: Record actual locations of control components, including control units, thermostats and sensors, trunk cable routing, junction boxes, transformers, box addresses.

1. Revise shop drawings to reflect actual installation and operating sequences.

2. Include submittal data in final "Record Documents" form.

3. All start-up/checkout documentation shall be initial and signed by the on-site control technician with intimate knowledge of the project.

4. Provide start-up/checkout documentations for all DDC controllers connected to the BMS network. Documentation shall include all controller points used and unused (spare). Furthermore, all final settings, calibration, coefficient values, K factors, spanning, actual spring ranges, etc., shall be indicated for all active points in use.

5. Revise all control sequences of operation. Sequences of operation that restate the Design Engineer's sequences will not be acceptable. Complete details will be given within the sequences of operation provided by the Contractor. Details shall include, but not be limited to, the following items: Control strategy, timers, delays, logic sequencing, start/stop, end devices involved, sensors involved, set points, globally commanded values, shared data between panels and controllers.

I. Operations and Maintenance Data:

1. Include interconnection wiring diagrams for completed field installed systems with identified and numbered system components and devices.

2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

3. Include inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.

1.07 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.08 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Perform work in accordance with NFPA 70 and Divisions 26, 27 and 28 specifications.

C. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed within the State in which the project is located.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years of documented experience.

E. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum ten (10) years of documented experience and approved by manufacturer.

F. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.10 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. The system specified herein and shown on the drawings shall be guaranteed to be free from original defects in both material and workmanship for a period of twelve (12) months of normal use and service, excepting damages from other causes. This guarantee shall become effective starting the date the Contract work is accepted as complete by the Owner and in accordance with the General Provisions/Conditions.

C. Provide five (5) year manufacturer's warranty for field programmable micro-processor based units.

D. Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.11 MAINTENANCE SERVICE

A. Provide service and maintenance of energy management and control systems for one (1) year from Date of Substantial Completion/Acceptance of System by Owner.

B. Provide two (2) complete inspections during the first year, one (1) in each season, to inspect, calibrate and adjust controls as required and submit written reports.

1.12 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software shall enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.

2. Limiting copying.

3. Preserving confidentiality.

4. Prohibiting transfer to a third party.

1.11 GENERAL

A. Acceptable manufactures subject to compliance with the specifications

1. Johnson Controls or approved equal.

B. The entire system and all control components shall be powered with emergency power.

C. All electrical work shall comply with Divisions 25, 27 and 28 Specifications.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 ELECTRIC LOW VOLTAGE WIRING

A. Furnish all labor and material to install the necessary wiring to accomplish the successful and complete operation of the new automatic system (DDC).

B. All electric wiring, wiring connections and all interlocking required for the installation of the temperature control system, as herein specified, shall be provided by the Contractor, unless specifically shown on the Electrical drawings or called for in the Electrical specifications.

C. Furnish all labor and material to install necessary relays, general purpose enclosures and appurtenances to control designated devices relative to the DDC.

D. All wiring throughout shall be concealed where possible.

E. All conduit used shall be EMT, 3/4" minimum size or larger. Conduit sizes shall be large enough to permit the individual conductors to be readily installed or withdrawn without damage to the conductors or their insulation. Splicing of wires will be permitted only in junction boxes or pull boxes. Conduit shall be rigid up to 12'-0″ AFF in mechanical rooms.

F. Conduit shall never to be relied upon for a fault current and safety ground return conductor.

G. All UL category UUKL portions of the system shall be in conduit.

H. All UL category UUKL portions of the system shall be powered from emergency power.

I. The ground system shall not be used as a current carrying conductor except for faults and noise suppression. The grounding system shall be used to control noise and transients which might affect the operation of the automation system. As such, the ground requirements shall be in excess of a grounding system used solely for physical protection minimum (Code requirement).

J. In all cases, the bond to ground shall be as short as possible. A ground point shall be derated by one (1) point (in order of preference) for each 50'-0″ of conductor run between it and the automation equipment to be grounded. Therefore, a water pipe bond located 10'-0″ away will be preferable to a structural steel bond located 150'-0″ away.

K. Set screw connectors shall be galvanized or plated steel. White metal cast type will not be permitted.

L. Flexible conduit shall be used at field devices, i.e., pressure switches, flow switches, temperature devices, etc. Convolutions shall be steel, interlocked

continuously. Aluminum will not be permitted. "Liquidtight" shall be used in wet locations. Flexible connector shall be a minimum of 18" long.

M. Only core drilling is permitted to pierce the floors in the electrical closets and elsewhere. The use of water for drilling shall be controlled by a suitable vacuum system, using proper dams to prevent damage to floors below. The ATC Contractor shall be responsible for providing a suitable sleeve in all core drilled holes as specified herein.

N. All wiring shall be run in EMT as noted below:

1.	Sensor to Panel (Block Wall):	In Wall Conduit (EMT)
2.	Sensor to Panel (Stud Wall):	In New Conduit (EMT)
3.	Sensor to Panel (Mechanical Room):	In New Conduit (EMT)
4.	Panel to Front End Workstation:	In New Conduit (EMT)
5.	Front End:	In New Conduit (EMT)

O. Wiring

1. Type THHN solid #18 AWG for control wiring in dry location up to 194°F.

2. Type THWN in wet location up to 167°F (solid #18 AWG).

3. Twisted shielded pair (18 gauge), with PVC cover, Belden #8760 or approved equal.

4. Conduit is not considered as a shield.

5. All signal wiring to all field devices shall be run with no splices, separately from any wiring having voltage greater than 30 volts.

P. The Contractor shall install all shielded cable and ground systems in accordance with Division 23. The installation of ground loops shall not affect any sensing or control circuits.

Q. All devices and equipment shall be mounted in minimum NEMA 1 enclosures.

R. In addition to the requirements specified above, all communication wiring cables shall include a minimum of (1) individually 100% shielded pair ([2] conductors) as unused spare conductors. Where the number of conductors and specific cable specified above for each type of communication wiring will not meet this

requirement for spare conductors, Contractor shall provide approved equivalent product of Belden or other manufacturer with the necessary number of conductors and which meets the requirements specified above.

S. Low Voltage Control Wiring (30 VAC or Less)

1. Low voltage control wiring shall be minimum 16 gauge, or heavier if required, twisted pair, 100% shielded with PVC cover Belden #9316 or approved equivalent product of other manufacturers run in conduit with no splices, separate from any wiring above 30 volts.

T. Coordination of Interfacing/Interlocking

1. The Contractor shall be responsible for coordinating all required interface/interlocking software, software logic, sequencing and wiring necessary to provide a fully automated and fully functional operable system to meet or exceed the intent of the Design Engineer's Sequence of Operation. Coordination may include but not limited to the following at no additional cost to the Owner. Variable frequency drive (VFD) interlocking and wiring logic including software, relays factory/field installed wiring and/or VFD drive modifications. This would include coordination of miscellaneous points as specified under the point list in this specification. Systems to include all points, analog, digital, sensors wiring, software, wiring, communications gateways, etc., to connect and communicate to any Fire, Plumbing, HVAC, Lighting, ATC, Security, World Wide Web (Internet) systems installed under this project.

2.03 AUTOMATION SYSTEM ARCHITECTURE

A. Provide TekmarNet 4 Gateway 483, network server and all related items to complete the system.

B. Provide 284 Boiler controller for each boiler, Tekmar 654 Snow Melt Control and 090 or 094 (depending on length) snow/ice sensor, and Tekmar 091 Snow Melt Sensor Socket for each designated platform heating zone. All the components shall be compatible with TekmarNet 4 to provide fully automatic control system.

C. All respective Tekmar 654 controls are to be tied into the Tekmar 284 Boiler Controller via TekmarNet® communication

D. Tekmar Boiler Control 284 for each boiler shall accurately maintain a target water temperature. The target water temperature shall be based on outdoor temperature reset. The 284 communicates with a Building Automation System (BAS) using TekmarNet 4 Gateway 483 for remote monitoring & adjustment capability of the boiler. The Tekmar Boiler 284 shall have the following Features: Outdoor

temperature reset, Programmable schedules, tekmarNet®4 compatible, Condensing boiler groups, Modulating, single stage or two stage communication, Primary pump sequencing, Setpoint operation and Combustion air damper control.

E. The Tekmar Snow Melting Control 654 shall operate hydronic equipment to melt snow or ice from platforms, walkways, stairs, and ramps. The surface temperature for snow melting shall be controlled automatically to reduce operating energy costs. The 654's automatic start and stop function shall be used together with the Snow/Ice Sensor 090 or 094. Provide isolation relays and starters to operate pumps The Tekmar 654 Snow Melt Controller will have the following features: Automatic Snow / Ice Detection, Supports Both Inslab & Retrofit Aerial Sensors, Manual Start With Timer, Programmable Schedule, TekmarNet® Communication Compatible, Warm Weather Shut Down, Cold Weather Cut Out, Idling, Snow Melt Zoning With Priority, Tandem Snow / Ice Detection, Slab Protection, Storm EconoMelt, Manual Override, Snow Melt Zone Tracking, Scenes, Away Key, Exercising, Alert Output.

F. The Snow/Ice Sensor 090 is an in ground sensor used with Tekmar snow melting controls to automatically detect snow or ice on the platform or walkway. The 090 has 65 ft of wire. The 094 has 208 ft of wire. This sensor shall allows tekmar snow melting controls to automatically operate the snow/ice melt system only when snow or ice is present, while also providing temperature feedback to the control. The Tekmar 090 / 094 Snow Melt Sensor shall have the following features: Automatic snow/ice detection so melting systems only operate when needed, slab temperature reading, sensor surface temperature and sensor surface moisture level. Contractor shall determine the type of sensor, 090 or 094, depending on required length at the field.

G. The Snow/Ice Sensor Socket 091 shall provide a mounting solution for the Automatic Snow/Ice Sensor 090 or 094. It is intended to be installed directly into a concrete slab when the slab is poured, so that the 090 or 094 can be installed into it once dry.

H. General

1. The Automation System shall consist of a number of Nodes and associated equipment connected by industry standard network practices. All communication between Nodes shall be by digital means only.

2. The Automation System network shall at minimum comprise of the following:

A. Operator Workstations – fixed and portable.

B. Network processing, data storage and communication equipment including file servers.

C. Routers, bridges, switches, hubs, modems and the like communications equipment.

D. Active processing Nodes including field panels.

E. Intelligent and addressable elements and end devices.

F. Third-party equipment interfaces.

G. Other components required for a complete and working Building Automation System.

3. The Building Automation System shall be accessible via Enterprise Intranet and Internet browser with security protection for user access.

4. The PC Workstations, File servers and principal network equipment shall be Apple Mac OS X

5. Provide licenses for all software residing in the Building Automation System and transfer these licenses to the Owner prior to completion.

I. Network

1. The Building Automation System shall incorporate a primary Tier 1 network. At the Contractor's option, the Automation System may also incorporate integrated secondary Tier 2 and tertiary Tier 3 networks.

2. The Automation System Network shall utilize an open architecture capable of:

A. Utilizing standard Ethernet communications and operate at a minimum speed of 10Mb/sec

B. Connecting via TekmarNet 4 Gateway 483

3. The Automation System network shall support both copper and optical fiber communication media.

J. Third-Party Interfaces

1. Automation System Contractor shall integrate real-time data from systems supplied by other trades as required.

2. The Automation System shall include necessary Automation System hardware equipment and software to allow data communications between the Automation System and systems supplied by other trades.

3. The trade contractor supplying other systems will provide their necessary hardware and software and will cooperate fully with the Automation System Contractor in a timely manner at their cost to ensure the complete data integration.

4. The Automation System Contractor shall provide all necessary coordination with vendors, contractors, owners, engineers, and other representatives at no additional cost to the Owner. Provide a completed fully functional, operational, integrated and seamless communicating infrastructure system.

K. Power Fail / Auto Restart

1. Provide for the automatic, orderly and predefined shutdown of parts or all of the Automation System following total loss of power to parts or all of the Automation System.

2. Provide for the automatic, orderly and predefined startup of parts or all of the Automation System following total loss of power to those parts or all of the Automation System. Archive and annunciate time and details of restoration.

3. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.

4. Maintain the Automation System real-time clock operation during periods of power outage for a minimum of 72 hours.

5. As part of this required feature of Power Fail/Auto Restart, the ATC Contractor shall furnish uninterruptible power supplies (UPS) for the entire Automation System networked infrastructure, including all third party interfaces, and determine feasibility, time, delays, shutdown, network traffic anticipated, etc.

L. Downloading and Uploading

1. Provide the capability to generate Automation System software-based sequences, database items and associated operational definition information and user-required revisions to same on designated Operator Workstations and the means to download same to the associated Application Nodes.

2. Provide the capability to upload Automation System operating software information, database items, sequences and alarms to the designated Operator Workstations with automatic archiving of same on the Operator Workstations. The functions of this Part shall be governed by the codes, approvals and regulations applying to each individual Automation System application.

3. The entire control system shall be approved and listed by UL 916 - Energy Management.

4. All DDC panels shall be powered through uninterruptible power sources (UPS) with sufficient capacity to ride through a (2) minute power interruption between transfers from normal to emergency power. UPS's and wiring shall be provided by the ATC Contractor.

5. Uploading or downloading functions performed at any location shall not affect controllers, communications, inputs, outputs at any location or address within the Automation Control Architecture nor shall any controller level functions be disrupted in any manner.

2.04 WEB SERVER, OPERATOR INTERFACE WORKSTATION

A. Acceptable Manufacturers subject to compliance with the specification:

1. Apple Mac OS X

B. General

1. Furnish portable operator's terminal functioning as web server for system. Portable operator's terminal shall allow for local accessing of program information.

C. Functionality of the portable operator's terminal connected at any high or lower level controller:

1. Access all controllers on the network.

2. Backup and/or restore controller data bases for all system panels, not just the DDC controller.

3. Display all point, selected point and alarm point summaries.

4. Display trending, historical and totalization information.

5. Add, modify, and/or delete any existing or new system point.

6. Command, change setpoint, enable/disable any system point vertical or physical.

7. Program and load custom control sequences as well as standard energy management programs.

D. Connection of a POT on controller to a distributed control processor shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally-initiated commands and system modification.

E. Portable operator terminal access to controller shall be password-controlled and menu-driven.

2.05 OPERATOR INTERFACE WORKSTATION

A. The Contractor shall provide all the necessary hardware and software to interface with the existing Central Facility Management System. A gateway between each system provided under this section and the CFMS system shall be provided by the ATC Contractor. The gateway shall allow the following:

1. Monitoring and commanding of all points of each system. Limited point sharing between the OCC and native systems is not acceptable except when using bundled point technology to control terminal equipment. The bundle point information may be passed to the CFMS via a virtual terminal direct connection. This connection shall be over the Ethernet data highway and shown on the CFMS PC as an inset window on the screen. Each bundled point shall be unbundled to continuously pass the actual value of the controlled variable (e.g. room temperature, face velocity) and the controlled variable setpoint. If a virtual terminal connection is not possible, the ATC Contractor shall pass the bundled point through the gateway and Comdale shall unbundle the information for display. Bundled points shall not be allowed for primary HVAC equipment.

2. Trend reports shall be compiled by the CFMS; however, point information and format shall be provided to the CFMS from the native system as directed.

3. The CAD drawings for the native system shall be capable of being located into the CFMS for the purpose of making dynamic graphics.

B. Transmission of the native system to the CFMS shall be via Ethernet. All necessary labor and material to tie into the existing campus Ethernet data highway shall be provided under this section.

C. Each native system shall have an CFMS gateway unless otherwise provided for in the specification.

D. The cost to develop the gateway shall be provided under this section. The labor to check out and verify each developed gateway shall be included under this section. The gateway operation must be verified in the presence of and signed-off by the Owner's CFMS representative.

E. The cost to create graphics, check out, program and any other work necessary to provide a fully functioning CFMS interface with the new Automation System control systems shall be included under this section.

F. Provided with a UPS system with one hour backup.

2.06 OPERATOR WORKSTATION

A. Basic Interface Description

1. Command Entry/Menu Selection Process: Operator Workstation interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.

2. Graphical and Text-Based Displays: At the option of the user, Operator Workstations shall provide consistent graphical or text-based displays of all system point and application data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all workstations.

B. Computer System Access Operation Control Stations (OCS) Description: This system access workstation is also referred to as the Building Automation System "Front end".

C. Provided Workstation with:

1. Workstation shall be general purpose, commercially available, personal computer with sufficient memory and processor capacity to perform all functions described in this specification.

2. Sufficient hard drive memory storage shall be provided to accommodate all fully configured point data bases, all application databases, all graphics

data bases, all user-defined reports, and all historical data archival as described in this specification.

3. The display provided for system operation shall have a diagonal screen measurement of no less than 15" (i.e. nominal 17” unit) and a minimum display resolution of no less than 640 x 320 pixels. Separate controls shall be provided for color, contrast, and brightness. The screen shall be non-reflective.

4. Each shall include the following:

   A. 3.0 GHz Pentium D processor with 1 GB of (SDRAM) random access memory.

   B. 3 1/2" diskette drive (high density).

   C. 17" color monitor 1280x1024(SGVA).

   D. SVGA video output (4 MB RAM).

   E. 160 GB fixed disk.

   F. HI-RES bus mouse.

   G. (1) Printer for alarms, minimum 240 characters/seconds.

   H. (1) Printer for reports, minimum Laser printer similar to HP 4000.

   I. 48X Read/Write CD Rom

   J. Telephone modem (56K)

   K. Campus network interface card

   L. Zip drive

   M. Server type platform shall have high performance RAID multiple fixed disk for hot redundancy. Provide minimum three fixed disks.

5. The operator functions provided by the system access Operator Terminal shall include, but not be limited to, the following:

   A. Start and Stop Points

   B. Modify Setpoints

   C. Modify PID Loop Setpoints

D. Override PID Control

E. Change Time/Date

F. Add/Modify Start/Stop Weekly Scheduling

G. Add/Modify Setpoint Weekly Scheduling

H. Enter Temporary Override Schedules

I. Define Holiday Schedules

J. View Analog Limits

K. Enter/Modify Analog Warning Limits

L. Enter/Modify Analog Alarm Limits

M. Enter/Modify Analog Differentials

N. View Point History Files

6. UPS system with one hour backup.

7. The workstation shall provide access to all real or calculated points in the controller to which it is connected, or any other controller in the network. This capability shall not be restricted to a subset of predefined "global points", but shall provide totally open exchange of data between the operator terminal and any DDC panel in the network.

8. Provide English language prompting to eliminate the need for the user to remember command formats or point names. Prompting shall be provided consistent with a user's password clearance and the types of points being displayed, to eliminate the possibility of operator error. Operator shall not require the use of special templates for navigation.

9. On-line, interactive user's "Help" manuals and tutorials shall be provided. Based upon operator request, the "help" function shall provide general system operating instructions, and specific descriptions of commands available in the currently displayed menus.

10. Identification for all real or calculated points shall be consistent for all network devices.

11. In addition to instantaneous summaries, the Operator's Terminal shall allow a user to view a Point History file for system points. Point History

files shall provide a record of value of analog points over the last 24 hours, at 30 minute intervals, or a record of the last (10) status changes for binary type points.

D. Dynamic Color Graphic Displays: Color graphics shall be provided as specified in the Execution portion of this specification to optimize system performance analysis and speed alarm recognition.

1. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration drill down scheme, menu selection, and text-based commands.

2. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

3. Windowing: The windowing environment of the workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

4. Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

A. The Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g. fans, cooling coils, filters, dampers, etc.), complete mechanical systems and electrical symbols.

B. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

1) Define symbols

2) Position and size symbols

3) Define background screens

4) Define connecting lines and curves

5) Locate, orient and size descriptive text

6) Define and display colors for all elements

7) Establish correlation between symbols or text and associated system points or other displays.

C. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including application specific controllers used for DDC unitary unit control.

5. Graphic

A. Provide graphic screens each system for this project.

B. Provide the following as a minimum:

1) Hot water system.

2) Each hot water system.

C. Provide graphic representation of building's form and site plans locating all equipment and panels.

D. Each hardware point shall be represented on graphic screen.

E. Selected software points shall be represented on respective process system graph as determined by the Owner. Examples of these software points are:

1) Control loop setpoint value.

2) Control loop auto/manual selection.

3) Calculated points such as run time.

4) Other vertical software points as required.

F. The Contractor shall coordinate all required graphical modes, features, binding, logic, etc., for a complete fully functional graphical operating system. All graphical schemes shall be submitted and approved by Architect/Engineer and Owner prior to programming.

E. Database Configuration

1. Provide database configuration for each hardware and software point.

2. Specific point parameters, such as alarm limits, alarm message, point name and point description shall be as approved by the Owner.

F. Trends

1. Provide real time and historical trends for hardware and software points as directed by the Owner.

2. Archiving or transfer of trend and historical data information shall not interfere, reduce communication throughout stow network speed or reduce local controller operation by any measure, due to trend or historical data capture rates and storage routines.

G. Internet / Intranet Browser

1. A multi-user color graphics and textual interface shall be provided that allows customers to access their Building Automation System data via the Internet or Intranet. This interface shall use HTML-based pages to send and receive data from a Building Automation System to a web browser.

2. Browser shall:

A. Automatically reflect any changes made to the Building Automation System without additional programming.

B. When installed behind a corporate firewall, shall work in conjunction with other security measures that have been implemented.

C. Allow the user to navigate and command the Building Automation System using the same format as the Operator Workstation.

D. Be an industry-standard browser

E. Provide user password access control.

F. Provide the means by which the user can create, edit and view groups of FMS data points.

G. Provide navigation tools for moving between the views. In addition, it shall provide tools for gaining access to help and for logging out of the system.

H. Emails/Cell Phones

1. Provide the means of sending of emails and automated cell phone calls, of personnel for user-defined Building Automation System events.

A. The ATC bid must include the man-hours required to program and customize this scheduling event.

I. Reports

1. Provide real time reports for hardware and software points as directed by the Owner.

2. The ATC Contractor shall program and test all alarming and alarm report routing to final devices such as printer, computers, pagers, monitors, cell phones, www, etc. Alarming requirements and routing shall be coordinated with the Owner by first compiling and all points listing for Owner's review prior to any programming.

J. Network Speed and Transmission

1. Network speed (communication rate) 10 megabits per second (MBPS) for all level one controllers.

2. Network configurations shall be Star, Bus or mixed (Star and Bus).

PART 3 - EXECUTION

3.01 PROJECT MANAGEMENT

A. The ATC Contractor shall designate a project manager who will be responsible for the following:

1. Construct and maintain project schedule.

2. On-site coordination with all applicable trades and subcontractors.

3. Authorized to accept and execute orders or instructions from Owner/Architect.

4. Attend project meetings as necessary to avoid conflicts and delays.

5. Make necessary field decisions relating to this scope of work.

6. Coordination/Single point of contact.

3.02 NUMBERING/NAMING CONVENTIONS

A. The Contractor shall collaborate with the Owner directly to determine the Owner's preference for naming conventions, etc. before entering the data in the system.

B. As a minimum the ATC Contractor shall submit to the Architect/Engineer and Owner the layout of the network, identifying all DDC controllers. Each controller will be identified by address and system being served. All physical and software generated objects, points and attributes shall be listed along with a description.

3.03 START-UP AND COMMISSIONING

A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the installer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.

B. Provide any recommendation for system modification in writing to Owner. Do not make any system modification, including operating parameters and control settings, without prior approval of Owner.

C. The ATC Contractor will provide industry standard checkout and startup checklists for each DDC controller installed for the project. If not standard is available, the ATC Contractor shall develop a spreadsheet in MS Excel format and submit to the Engineer for approval prior to system checkout.

3.04 INSTRUCTION AND ADJUSTMENT

A. The Contractor shall provide factory-trained instructor to give full instructions to the owner designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The Contractor shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00 AM to 5:00 PM weekdays.

B. Upon completion of the project, the Contractor shall:

1. Fine-tune and "de-bug" all software control loops, routines, programs and sequences of control associated with the control system supplied.

2. Completely adjust and make ready for use, all transmitters, relays, damper operators, valves, etc., provided under this Section. This Contractor shall furnish copies of complete, detailed, calibrating checkout and commissionary documentation for reach controller. Documentation shall

list each procedure and shall be signed by the control specialist performing the service.

3. Furnish a complete set of system operation manual, including standard manufacturers' operating manuals, complete as-built installation diagrams, and complete software hardcopy documentation, as well as a magnetic media back-up.

4. Provide an on-site training program for the Owner's staff in the operation and use of the control system. Training shall include three (2) segments, as follows:

   a. Segment 1 shall include 16 hours of classroom and hands-on training. This segment shall instruct personnel in the system configuration, component characteristics, control strategy on each controlled system and all requirements for daily operation and use of the system. This segment shall give the Owner's representative a working proficiency in the day-to-day operational requirements (i.e., system monitoring, alarm acknowledgment, HVAC system troubleshooting techniques, setpoint and time schedule adjustments, manual override, etc.).

   b. Segment 2 shall include 6 hours of on-site training. This segment will be geared for the Owner's designated prime operator. An emphasis on overall software management and manipulation shall be made, to allow the prime operator(s) to make control strategy and overall facility and system management changes as required. Attendees shall have attended Segment 1.

   c. All training shall take place at the site and at times mutually agreed to between that ATC Contractor and the Owner. The ATC Contractor shall provide to the Owner's designated representative, at least three (3) weeks before each segment, a course syllabus outline and schedule. The ATC Contractor shall provide all training material, reference material and training aids, as required, all as part of his Contract cost.

END OF SECTION 251000

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 APPLICATION

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. This Section applies to all sections of Division 26 of this Contract, except if specified otherwise in the individual section.

D. Electrical work, equipment and material shall be only that suitable for a commuter railroad station and shall be of the highest class, and shall be applied in the best manner and according to the best rules and usages of electric work. Where no specific requirements are given, the work and materials shall conform to the latest applicable standards of material and construction of nationally recognized associations.

1.2 SUBMITTALS

A. Submit the following in accordance with Standard Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. In accordance with the General and Special Conditions, specific items requiring submittals are specified in each individual section of Division 26. Shop drawings shall be submitted for review before procurement, fabrication, or delivery of such items to the jobsite. Partial submittals are not acceptable; such submittals will be returned without review.

C. Manufacturer's Data: Submittals for each manufactured item shall be manufacturer's descriptive literature, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts. Each submittal shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, specification reference, applicable Federal and industry specification references, and all other information necessary to establish Contract compliance.

D. Shop Drawings shall show types, sizes, accessories, elevations, floor plans, sectional views, installation details, elementary diagrams, and interconnection wiring diagrams. Wiring diagrams shall identify circuit terminals and shall indicate the internal wiring for each item of equipment and the interconnection between the items both internal and external. Point to point wiring diagrams are required. Elementary wiring diagrams shall contain a sequence of equipment operation. Contractor shall submit conduit routing drawings and station composite drawings detailing electrical equipment installation layouts for approval by Connecticut DOT/Amtrak prior to performing construction work. Drawings shall also indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If any equipment is nonconforming, the drawings shall be revised to show acceptable equipment and be resubmitted.

E. Standards Compliance: When materials or equipment are required to conform to the standards or organizations such as the American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturer's Association (NEMA), or Underwriters Laboratories (UL), proof of such conformance shall be submitted to the Engineer for approval. If an organization uses a label or listing to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified in the individual sections. In lieu of the label or listing, the Contractor shall submit a certificate from an independent testing organization competent to perform acceptable tests and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods, and that the item conforms to the specified organization's standard. For materials and equipment whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate of compliance from the manufacturer shall be submitted for approval. The certificate shall identify the manufacturer, the product, and the referenced standard and shall state that the manufacturer certifies that the product conforms to all requirements of the project specification and of the referenced standards listed.

F. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in the individual sections shall be submitted for approval.

G. Operation and Maintenance Manual: Submit where necessary conform to the requirements of Standard Form 816.

1.3 POSTED OPERATING INSTRUCTIONS

A. Operating instructions approved by Connecticut DOT/Amtrak shall be provided for each system and each principal piece of equipment for the use of operation and maintenance personnel. The operating instructions shall include wiring and control diagrams showing the complete layout of the entire system, including equipment, devices, and control sequence. Operating instructions shall be printed or engraved and shall be framed under glass or in approved laminated plastic and posted where

directed by the Engineer. Operating instructions shall be attached to or posted adjacent to each principal piece of equipment and shall include such instructions as startup, proper adjustment, operating lubrication, shutdown, safety precautions, procedure in the event of equipment failure, and any other necessary items of instruction as recommended by the manufacturer of the unit. Operating instructions exposed to the weather shall be made of weather-resisting materials or shall be suitably enclosed to be weather protected. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.4 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.5 DELIVERY AND STORAGE

B. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

C. Equipment and materials shall be properly stored, adequately protected and carefully handled to prevent damage before and during installation. Equipment and materials shall be handled, stored, and protected in accordance with the manufacturer's recommendations and as approved by the Engineer. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Outdoor storage of cable will not be permitted. Damaged or defective items, in the opinion of the Engineer, shall be replaced with new items at no additional cost to Amtrak.

1.6 CATALOGED PRODUCTS

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Materials and equipment shall be the cataloged products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest standard design that complies with the specification requirements. When two or more units of the same type, class, and size of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer. Each major component of equipment shall have the manufacturer's name, address and the model and serial number on a nameplate securely affixed in a conspicuous place, the nameplate of the distributing agent will not be acceptable.

1.7 MANUFACTURER'S RECOMMENDATIONS

A. Where installation procedures are specified to comply with the recommendations of the manufacturer of the material or equipment being installed, printed copies of these recommendations shall be furnished to the Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.8 MECHANICAL REQUIREMENTS

A. The interconnecting power wiring and conduit, control wiring and conduit as indicated on the drawings, and the electrical power circuits are included under this division. The electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment, and control wiring and conduit not indicated on the drawings are specified in the appropriate sections covering such work rather than in Division 26.

1.9 COORDINATION

A. Electrical work shall be coordinated with other trades involved in the construction project. All work shall be carefully laid out in advance, coordinating electrical features with architectural, structural, and mechanical features of construction.

1.10 COORDINATION WITH UTILITIES AND CONNECTICUT DOT/AMTRAK

A. Contractor shall comply with all local power company requirements.

B. Contractor shall contact the local telephone company and arrange for installation of telephone equipment.

1.11 CODES, LISTINGS AND STANDARDS

A. Electrical Codes: All electrical work covered by the Contract Documents shall conform to the requirements of National Electrical Code, 2011 Edition, and all other state and local codes as required.

B. Listings: All equipment and materials for which Underwriters Laboratories, Inc. (UL) provides product listing service shall be Underwriters Laboratories approved and bear the U.L. Label.

C. Equipment and materials wherever applicable shall conform to the following standards:

1. Illuminating Engineering Society (IES).

2. National Electrical Manufacturers Association (NEMA).

3. Institute of Electrical and Electronic Engineers (IEEE).

4. American National Standards Institute (ANSI).

5. Insulated Cable Engineers Association (ICEA).

1.12 ENCLOSURES

A. Furnish NEMA enclosures to suit location classification, unless otherwise shown on the drawings. The platform area shall be considered NEMA 4X utilizing stainless steel covers and PVC coated boxes and fittings.

1.13 POWER SUPPLY

A. Power will be obtained from the three phase, four wire, 60 hertz, 480/277 V service by the power utility company.

1.14 TEMPORARY SERVICE

A. The Electrical Contractor shall furnish and install a temporary 208/120V, 3-phase, 4-wire electric service. This service shall be obtained directly from utility and will be furnished complete with main disconnect, overcurrent protection, meter outlet, branch circuit breakers and wiring as required.

B. The Electrical Contractor shall make all necessary arrangements, and pay for permits and inspections and utility charges for the temporary service installation. Temporary systems shall comply with and meet the approval of Underwriters Inspection Agency authorized for the project.

C. Temporary service meter shall be registered in the name of the General Contractor and all energy charges for furnishing temporary electric power and construction power shall be borne by the Electrical Contractor.

D. Upon completion of the work, but prior to acceptance by Connecticut DOT/Amtrak, the Electrical Contractor shall remove all equipment associated with temporary service. The cost of such removals shall be included in the bid price.

1.15 PERMANENT ELECTRIC POWER SERVICE & EQUIPMENT

A. It shall be the responsibility of the Contractor to obtain from the utility all information required relative to connecting into their power supply. The Contractor shall abide by their requirements and if disagreement arises shall inform the Engineer of such disagreement. The Engineer will then consult with the utility company and any decisions resulting therefrom shall be binding on the Contractor.

B. Where changes in location of permanent service facilities are required or where power supplies are installed as excess distribution facilities by utility for which charges are made, the Contractor shall pay such charges to the Company when directed by the Construction Manager. The Connecticut DOT/Amtrak will reimburse the Contractor for such charges. Certified bills must accompany all Contractor requests for reimbursement.

C. All utility service equipment shall be subject to the approval of utility. The Contractor shall submit shop drawings showing the proposed utility service equipment to utility for compliance with the company's requirements as to service and metering arrangements including property line splice box/C.T. cabinet and termination devices, etc. Such approval by utility shall be submitted to Connecticut DOT/Amtrak together with said shop drawings for Connecticut DOT/Amtrak approval.

1.16 GROUNDING

A. No ground connections to the track rails or to the neutral conductor of the utility feeder will be permitted.

1.17 LIGHTING FIXTURES

A. The Contractor shall not proceed with the manufacture or installation of any lighting fixtures before approval of the Engineer is obtained.

B. The Contractor shall submit engineering data for the lighting fixtures to be installed under this Contract as specified in Section 265100.

1.18 SAMPLES OF ELECTRICAL EQUIPMENT

A. The Contractor shall submit samples of conduits, boxes, fixtures, wiring and other equipment for approval before proceeding with the electrical work.

1.19 SPECIAL REQUIREMENT FOR APPROVAL OF "OR EQUAL" ELECTRICAL DEVICES

A. The electrical distribution system as specified and shown on the Contract Drawings has been designed to provide system protection and selectivity on inrush, starting,

normal overcurrent and ground fault conditions. Any request to install devices other than those specified and shown on the Contract Drawings shall include sufficient information to determine their equality with the devices specified. This information shall include, but not be limited to, the following:

1. For fuses and circuit breakers, time-current curves for the proposed devices comparing them to the devices specified and shown on the Contract Drawings. Manufacturer's curves shall be considered acceptable for this purpose of system protection and selectivity.

2. For transformers, the percent impedance and X/R ratio as supplied by the proposed manufacturer shall be considered acceptable for this purpose of system protection.

3. In addition, the Contractor is required to provide a complete system coordination study to show equality of the proposed devices, prior to their approval.

1.20 EXISTING CONDITIONS AND RELOCATIONS

A. The Contractor, before submitting his proposal, shall visit the site and shall be responsible for having ascertained local conditions, such as location, accessibility and general character of the site, the character and extent of any existing work within or adjacent to the site, and any other work being performed on the site at the time of submitting his proposal. The Contractor shall fully examine all the drawings relating to the work and shall become completely informed as to the extent and character of the work required and prevailing existing conditions. No allowances will be made for the Contractor's failure to avail himself of such information.

1.21 LOCATIONS - APPROXIMATE

A. The locations of equipment, boxes, switches, outlets, and similar matters as shown on the Contract Drawings are approximate only and exact locations shall be determined in the field by the Contractor. In case of interference with other work or of erroneous locations with respect to equipment or structures the Contractor shall furnish all labor and materials to complete the work in an approved manner, at no additional cost to Connecticut DOT/Amtrak.

1.22 DRAWINGS - DIAGRAMMATIC

A. Conduits and wiring are shown diagrammatically only and in some cases only homeruns are shown. Contractor shall furnish, install, and place in satisfactory condition ready for operation, all conduits, cables, and all other material needed for lighting, power, and other electrical systems shown or indicated in the Contract Documents. Additional conduits and the required wiring shall be installed by the Contractor wherever needed to complete the installation of the specific equipment furnished and to meet NEC requirements at no additional cost to the Connecticut DOT/Amtrak.

1.23 PAINTING

A. All shop painting shall be accomplished at the manufacturer facilities meeting ANSI standards and shall be included in the bid price for equipment and materials furnished under this division. All scratched or base surfaces of factory painted equipment shall be touched up with the same color paints as used originally.

1.24 CLOSEOUT PROCEDURES

A. General coordination is required. Closeout procedures shall be sequenced properly so that work will not be endangered or damaged, and that every required performance will be fully tested and demonstrated.

B. System performance test runs are required. Test runs of electrical systems shall be coordinated with test runs of equipment served.

C. During test runs, the Contractor shall make final corrections or adjustments of systems to refine and improve performances where possible, including noise and vibration reductions, elimination of hazards, better response of controls, signals and alarms, and similar system performance improvements.

D. Cleaning and lubrication is required. After final performance test run of each electrical system, the Contractor shall clean system both externally and internally and shall comply with manufacturer's instructions for lubrication. Contractor shall remove excess lubrication, touch up minor damage to factory-painted finishes.

1.25 DOCUMENTATION PROCEDURES

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

B. Signed commitments are required. The transfer of the electrical system to Connecticut DOT/Amtrak for operation will not proceed until guarantees, warranties, performance certifications, maintenance agreements and similar commitments to be signed by Contractor and other entities have been executed

and transmitted to Connecticut DOT/Amtrak for placement in records.

1.26 GUARANTEE

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. The Contractor shall guarantee and service the entire installation for a period of one (1) year from the date of the final acceptance of the installation by Connecticut DOT/Amtrak.

C. The Contractor shall, during the period of the guarantee, replace or repair at his own expense any piece of equipment and/or material which is found to be defective. The replacement or repair shall be done as soon as notified by Connecticut DOT/Amtrak or its authorized representative. The Contractor shall also repair all damage to surrounding work caused by the failure, repair or replacement of the defective equipment or material.

1.27 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall furnish and install all electrical equipment, materials and also labor, machinery, tools, transportation, procurement of all necessary permits, certificates and other incidental services, whether described in these specifications and drawings or not, to provide a satisfactory operating electrical installation.

B. The Contractor shall familiarize himself with the installation requirements of the local electrical utilities, and shall furnish and install the equipment in complete accordance therewith.

C. Contractor shall perform all operations necessary to install, adjust and put into satisfactory operation all electrical equipment.

D. Contractor shall provide and install conduits, cable and electrical connections, adjustments, and testing of mechanical equipment that requires electrical power.

E. Contractor shall install UL Listed firestop material on all rated walls per Specification 230584 “Through-penetration firestop systems”.

F. Providing and installing all required systems and equipment grounding as required to properly ground all system equipment in conformance with the latest requirements of the NEC and best modern practice.

G. The specifications and Contract Drawings are complimentary; items shown in one, but not in the other shall be as binding as if included in both. Where there is a discrepancy, the Contractor shall assume the most expensive material and/or method

of installation for bidding purposes and refer the discrepancy to the Engineer for a decision.

1.28 RECORD DRAWINGS

A. The Contractor shall furnish to the Engineer two (2) CD's of record drawings in AutoCad2000 format and two (2) sets of black-on-white prints, satisfactory to Connecticut DOT/Amtrak, of all electrical equipment installed under this Contract, showing:

1. Electrical equipment as finally installed.

2. The Contractor's approved working drawings.

3. The Manufacturer's name and address.

B. These reproductions and black-on-white prints shall be 26 inches by 32 inches.

C. Drawings:

1. Individual detail wiring drawings shall be furnished showing all connections to all equipment in the final systems furnished or modified under this contract, and drawings showing cable and conduit runs as installed.

2. Final as-built layout drawings of field equipment, for the various types of installations, shall be furnished by the Contractor.

D. Before field installation work shall commence, the Contractor shall submit for approval the drawings that he is required to furnish as specified elsewhere herein.

E. There shall be no substantial completion until all final drawings and manuals have been received by Connecticut DOT/Amtrak.

F. There shall be no final acceptance of contract until all final drawings and manuals have been received by Connecticut DOT/Amtrak.

G. The guarantee shall not start until all final drawings and manuals have been delivered to Connecticut DOT/Amtrak.

H. The Contractor shall be responsible for and shall correct all wiring diagrams of telephone terminal boxes.

I. All manuals provided by the Contractor shall be originals. Copies of original manuals will not be acceptable.

1.29 CLEAN UP

A. The Contractor shall execute cleaning, during progress of the Work, including periods when Work is suspended and at completion of the Work.

B. Requirements of Regulatory Agencies:

1. In addition to the requirements herein, maintain the cleanliness of the Work and surrounding premises within the Work limits so as to comply with federal and local fire and safety laws, ordinances, codes and regulations.

2. Comply with all federal and local anti-pollution laws, ordinances, codes and regulations when disposing of waste materials, debris and rubbish.

C. The Contractor shall schedule cleaning and disposal operations:

1. So that dust, wash water or other contaminants generated during such operations do not damage or mar painted or finished surfaces.

2. To prevent accumulation of dust, dirt, debris, rubbish and waste materials on or within the Work or on the premises surrounding the Work.

D. Waste Material Disposal:

1. Dispose of all waste materials, surplus materials, debris and rubbish off the Project site.

2. Do not burn or bury rubbish and waste materials on the Project site.

3. Do not dispose of volatile or hazardous wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.

4. Do not discharge wastes into streams or waterways.

E. Cleaning Materials:

1. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

2. Use each type of cleaning material on only those surfaces recommended by the cleaning material manufacturer.

3. Use only materials which will not create hazards to health or property.

F. During Construction:

1. Keep the Work and surrounding premises within work limits free of accumulations of dirt, dust, waste materials, debris and rubbish.

2. Keep dust generating areas wetted down.

3. Provide suitable containers for storage of waste materials, debris and rubbish until time of disposal.

4. Dispose of waste, debris and rubbish off site at legal disposal areas.

G. When the Project is completed, the Contractor shall:

1. Remove and dispose of all excess or waste materials, debris, rubbish, and temporary facilities from the site, structures and all facilities.

2. Repair pavement, roads, sod, and all other areas affected by construction operations and restore them to original condition or to minimum condition specified.

3. Remove spatter, grease, stains, fingerprints, dirt, dust, labels, tags, packing materials and other foreign items or substances from interior and exterior surfaces, equipment, signs and lettering.

4. Repair, patch and touch-up chipped, scratched, dented or otherwise marred surfaces to match specified finish.

5. Remove paint, clean and restore all equipment and material nameplates, labels and other identification markings.

6. Clean all floors, slabs, pavements, and ground surfaces.

7. Maintain cleaning until acceptance and occupation by Connecticut DOT/Amtrak.

PART 2 - PRODUCTS

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

PART 3 - EXECUTION

Not Used.

END OF SECTION 260500

SECTION 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section includes wires and cables and wiring connectors and connections.

D. Related Sections:
1. Section 260553 - Identification for Electrical Systems
2. Section 260533 – Raceway and Boxes for Electrical Systems.

E. The Contractor shall supply, install, test and commission into service, all conductors indicated on the drawings.

1.2 REFERENCES

A. National Fire Protection Association (NFPA), including the National Electrical Code (NFPA 70) and NFPA 130

B. American National Standards Institute (ANSI).

C. Institute of Electrical and Electronics Engineers (IEEE).

D. Underwriters Laboratories Inc. (UL).

E. National Electrical Manufacturers Association (NEMA).

F. Insulated Cable Engineers Association (ICEA).

1.3 SYSTEM DESCRIPTION

A. Product Requirements: Provide products as follows:
   1. All wire and cable shall have copper conductors except where indicated otherwise. Copper wires shall be soft drawn, annealed, 98 percent conductivity.
   2. Stranded conductor for feeders and branch circuits.
   3. Conductor not smaller than 10 AWG for power and lighting circuits. 120-volt branch circuits of more than 100 ft and 277-volt branch circuits of more than 150 ft from center of load to panel shall be No. 10 AWG minimum.

B. Wiring Methods: Provide the following wiring methods:
   1. Concealed Dry Interior Locations: Use only XHHW-2 insulation, in raceway.
   2. Exposed Dry Interior Locations: Use only XHHW-2 insulation, in raceway.
   3. Wet or Damp Interior/Exterior Locations: Use only XHHW-2 insulation, in raceway.

1.4 DESIGN REQUIREMENTS

A. Conductor sizes are based on copper.

1.5 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data, Submittal Requirements:
   Before installation of wires and cables, submit the following information for each type and size of wire and cable:
   l. Manufacturer of wire and cable, and certificate of compliance;
   2. Number and size of strands composing each conductor;
   3. Conductor insulation composition type in accordance with National Electrical Code and thickness in mils;
   4. Average overall diameter of finished wire and cable;
   5. Minimum insulation resistance in megohms per 1000 feet at 30 degrees C ambient;
   6. Jacket composition and thickness in mils;
   7. Total number of conductors per cable;
   8. Shield material (if any) and thickness;

1.6 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.8 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.9 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.10 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.11 COORDINATION

A. Where wire and cable destination is indicated and routing is not shown the contractor shall determine routing and lengths required.

B. Wire and cable routing indicated is approximate and shall be recalculated by contractor.

PART 2 PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 WIRES

A. Manufacturers:
   1. American Insulated Wire Corporation.
      Or
   2. Approved equal

B. Product Description: Single conductor 600 volt insulated wire.

C. Conductor: Compressed concentric stranded copper. The connection lug shall be adequately sized for compressed cables.

D. Insulation: Type XHHW-2 insulation conforming to UL 44 for feeders and branch circuits.

2.3 WIRING CONNECTORS

A. Insulated Spring Wire Connectors: Buchanan Construction Products or approved equal.

B. Insulated Crimp Connectors: Buchanan Construction Products or approved equal.

C. Uninsulated Crimp Connectors: Burndy Corp. Hydent or approved equal.

D. Wireway Taps: O-Z/Gedney Co. PMX or PT, with covers PMXC or PTC, or approved equal.

E. Terminals: Burndy Corp. Nylon insulated terminals or approved equal.

F. Lugs: Burndy Corp. or approved equal.

G. Rubber Electrical Tape: 3M or approved equal.

H. Color Coding Tape: 3M or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify interiors have been protected from weather.

B. Verify mechanical work likely to damage wire and cable has been completed.

C. Verify raceway installation is complete and supported.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

B. Transmit submittals required by this Section.

C. Furnish products as indicated.

3.3 EXISTING WORK

A. Not applicable

3.4 INSTALLATION

A. Route wire and cable to meet project conditions.

B. Neatly train and lace wiring inside boxes, equipment, and panel boards.

C. Identify wire and cable under provisions of Section 260553. Identify each conductor with its circuit number or other designation indicated.

D. Special Techniques--Building Wire in Raceway:
1. Pull conductors into raceway at same time.
2. Install wiring after the raceway system is completed and cleaned, and all work that may damage wiring has been completed.
3. Pull conductors using only UL listed wire pulling lubricant and polypropylene dragline.

E. Special Techniques - Wiring Connections:
1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
7. Arrange conductors in groups of three phases and neutral (if used) in wireways and large pullboxes
8. Install splices only in junction boxes.
9. In dry locations, splice conductors No. 8 AWG and smaller using insulated spring wire connectors or insulated crimp connectors. For conductors No. 6 AWG and larger, use uninsulated crimp connectors and apply electrical filler tape to fill the indentations, and rubber electrical tape to provide insulation equivalent to the conductor insulation.
10. In damp locations, make splices similar to dry locations, with the addition of moisture-sealing tape over the insulation.
11. In wet locations, make splices using uninsulated crimp connectors, and insulate with resin splice kits or heat-shrinkable splices.

12. For conductors No. 10 AWG and smaller, use terminals to connect to equipment designed for use with terminals.
13. For conductors No. 8 AWG and larger, use lugs to connect to flat bus bars or to equipment designed for use with lugs.
14. Arrange conductors in cabinets, panels, lighting contactor, panels, etc., neatly cut to proper length, and remove surplus conductor. Terminate, bridle and secure in an approved manner. List all circuits emanating from power, distribution, and lighting panelboards by function on the directory card. Identify all circuits entering panelboards or other control cabinets by directory card listing terminal block number and function or by means of tags securely fastened to the conductors.
15. Single-phase branch circuits of different phases may be installed as multi-wire branch circuits having a common neutral conductor, except that lighting branch circuits shall not share a common neutral with receptacle branch circuits.

3.5 WIRE COLOR

A. Refer to Section 260553

3.6 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. This section specifies furnishing, installing, connecting, and testing of a complete grounding and bonding system.

D. All permanent or temporary metal structures shall be bonded to form a continuous conductive path. All structural steel, including, but not limited to, platform bents, overpass columns, stair stringers or canopy columns, shall be bonded to the main bonding conductor using a 4/0 AWG conductor. All terminations of the conductors shall be exothermic welded.

E. All other non-structural steel shall be bonded to the main bonding conductor using a # 1/0 AWG conductor. This includes, but is not limited to, buildings, bridges, bungalows, fences, metal roofs of buildings, shelters, light poles, communication poles, power poles, metal handrails, metal guardrails, signs, vending machines, metal seating, metal expansion joints, and any ramps.

1.2 REFERENCE STANDARDS

A. American National Standard Institute (ANSI)C33.8/UL6467 Grounding and Bonding Equipment, Safety Standard

B. National Fire Protection Association (NFPA)
70-2005 National Electrical Code (NEC)

C. American Society for Testing And Materials (ASTM)
B3 Soft or Annealed Copper Wire

D. National Electrical Safety Code (NESC)
9 Grounding

E. Association of American Railroads (AAR)

F. American National Standards Institute (ANSI)

G. American Railway Engineering Association (AREA)

H. Institute of Electrical and Electronic Engineers (IEEE)
142 Recommended Practice for Grounding of Industrial and Commercial Power Systems

I. Insulated Power Cable Engineers Association (IPCEA)

J. NEMA National Electrical Manufactures Association

K. Underwriters Laboratories (UL)
467 Grounding and Equipment

1.3 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. In accordance with the General and Special Conditions, the Contractor shall submit: Certified test report stating that grounding system measures a maximum of 5 ohms to ground.

1.4 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.5 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.6 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.7 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.1 GROUNDING AND BONDING EQUIPMENT

A. Ground Rods: Solid ground rod, copper or copper-clad steel, 3/4 inch diameter by 10 feet long, or of required length in 10 foot sections. The copper shall have a minimum wall thickness of 0.013 inch.

B. Grounding Conductor: Ground electrode conductors: Insulated or bare conductor as shown, in accordance with the following requirements:

1. Insulated conductor: Conforming to the requirements for wire as specified elsewhere, NEC or ANSI C33.8/UL 467.

2. Bare conductor ASTM B3: Soft-drawn tinned-copper conductor Class B stranded.

3. Size: Ground wire imbedded in foundations and aerial ground wire shall be 4/0 AWG stranded copper conductor. Connections from the ground grid to ground bus, building steel,and electrical panels shall be 4/0 AWG. Connections to buildings, bridges, bungalows, fences, and metal roofs of buildings, shelters, light poles, communication poles, power poles, metal handrails, metal guardrails, signs, vending machines, metal seating, metal expansion joints, and any ramps shall be # 1/0 AWG.

4. Equipment grounding conductor: Conductors for grounding and bonding shall be ASTM B8, Class B stranded annealed copper, and sized as indicated on the plans. Conforming to the requirements of single-conductor cable as specified in Section 260519, size in accordance with Table 250-122 of NEC.

5. Terminal lugs for 4/0 AWG and smaller conductor: Compression type copper terminal lugs.

6. Ground connector: OZ, Type KG or equal, in accordance with the following requirements:

   a. Two piece, designed for connecting grounding conductor to bus bar.

   b. Copper alloy body and silicon bronze bolt, nut and washer with interlocking clamp.

7. Jumpers: Copper braided flexible jumper, size as required.

PART 3 - EXECUTION

3.1 GROUNDING

A. Grounding Connections:

1. Exothermic weld buried ground connections. Make welds in accordance with manufacturer's requirements, clean and coat with before backfilling.

2. Use terminal lug to connect grounding conductor to equipment enclosure. Use ground connector to connect grounding conductor to equipment ground bus furnished within equipment. Secure connector or terminal lugs to the conductor to engage all strands equally. Install terminal lug using tools and pressure recommended by the manufacturer. Indent mark terminal lug with the number of die used for installation.

B. Ground Loop: Install ground grid consisting of grounding electrode conductors and ground rods buried in earth in a pattern and at locations as shown, with the following requirements:

1. Top of ground rod and grid conductor 30 inches below unfinished surface or 6 inches below bottom of finished floor slab.

2. A #4/0 AWG bonding conductor shall be secured to the underside of the platform at least 12 inches from the edge of the train side of platform, by an approved method at no more than 5-foot intervals.

3. The bonding conductor shall run the entire length of each platform and connect to supporting steel and exposed reinforcing bars.

3. Interconnect ground rods using 4/0 AWG conductor.

C. Equipment Grounding Conductor: Provide equipment grounding conductor for following services and as shown:

1. All feeders.

2. All branch circuits.

D. Grounding of Service Equipment: Ground service equipment in accordance with NEC.

E. Grounding for Personnel Safety: Bond and ground exposed metallic structures in open areas to separate grounding electrode in accordance with the following requirements:

1. Light Standards: Bond and ground each light to a separate 3/4 inch diameter by 10-foot long ground rod, located in adjacent handhole, using 1/0 AWG insulated grounding conductor.

2. Platform: Bond and ground all metallic equipment, structures, railings, benches, columns, fencings, trash cans, gutters, pay phones, shelters, TVM, and all metallic items within 25 feet of tracks, ladders, building steel, water piping, etc., to main ground conductor run on underside of platform. For providing electrical continuity, where necessary, install flexible copper braided jumper or 4/0 AWG insulated grounding conductor.

3. Ground all temporary construction equipment and structures.

Ground all separately derived systems according to Article 250 of the NEC. The grounding of these, such as 120/208 volt transformers will not be shown on the drawings but are the responsibility of the Contractor.

3.2 FIELD QUALITY CONTROL

A. The Contractor shall perform a ground Test. The Engineer shall be notified at least 5 days prior to the test. Ground and weather conditions shall be noted at the time of the test. . Ground resistance is to not to exceed 5 ohms for ground grid/bus in main distrubition panels. The Contractor shall provide additional grounding equipment until the ground resistance is measured consistently less than 5 ohms under dry conditions. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

B. If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

C. Install a driven ground rod at handholes close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before handhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor within handhole.

D. To meet resistance requirements, install additional ground rods and 4/0 AWG cable.

E. Test equipment enclosure, metallic conduit and raceway, fence, and light standards for continuity to grounding system.

F. Padmounted transformers, install four ground rods and cable loop. Ground padmounted equipment and noncurrent-carrying metal items associated with by connecting them to underground cable and grounding electrodes.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. This section specifies the furnishing and installation of electrical equipment supporting devices complete in place.

1.2 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product data

C. Related Sections:

260533 - Raceway and Boxes for Electrical Systems

260548 – Vibration and Seismic Control for Electrical Systems

1.3 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.6 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.7 GENERAL REQUIREMENTS

A. Underground Service: Underground service into buildings shall terminate as indicated, service conductors shall be continuous to the interior terminating point indicated from the utility transformers. Connections of the underground service to the service switch, panelboard is included. Ends of the underground conduit shall be protected by threaded caps until connections are made.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 MATERIALS

A. Fasteners: Furnish all fasteners and hardware compatible with the materials and methods required for attachment of supporting devices.

B. Slotted - PVC coated Type Concrete Inserts: Galvanized pressed steel plate complying with ASTM A283; box-type welded construction with slot designed to receive steelnut and with knockout cover; hot-dipped galvanized in compliance with ASTM A386 and PVC coated.

C. Masonry Anchorage Devices: Expansion shields shall be of Type 316 stainless steel as follows:

1. Furnish expansion shields for machine screws and bolts 1/4 inch; head-out embedded nut type, multiple unit class, Group I, Type 1, Class 1.
2. Furnish expansion shields for machine screws and bolts large than 1/4 inch in size; head-out embedded nut type, multiple unit class, Group I, Type 1, Class 1.
3. Furnish bolt anchor expansion shield for lag bolts, stainless steel, long-shield anchors class, Group II, Type 1, Class 1.

4. Furnish bolt anchor expansion shields for bolts, closed-end bottom bearing class, Group II, Type 2, Class 1.
5. Toggle Bolts: Type 316 stainless steel tumblewing type. Type, class and style as required.

D. Nuts, Bolts, Screws and Washers:

1. General: Furnish Type 316 stainless steel fasteners for exterior use or where built into exterior walls. Furnish fasteners for the type, grade and class required for the particular installation.
2. Standard Nuts and Bolts: Regular hexagon head type, complying with ASTM A307, Grade A, Type 316 stainless steel material.
3. Lag Bolts: Square head type of Type 316 stainless steel.
4. Machine Screws: Type 316 stainless steel.
5. Wood Screws: Flat head Type 316 stainless steel.
6. Plain Washers: Round, general assembly grade Type 316 stainless steel.
7. Lock Washers: Helical spring Type 316 stainless steel.
8. "C" Beam Clamps: for conduit size and loading, malleable iron, PVC-coated.
9. Pipe Straps: 2 hole steel conduit straps Type 316 stainless steel.
10. Pipe Clamps: 1 hole malleable iron type clamps with Type 316 stainless steel clamp backs and hardware.
11. Channel Support System and Accessories: Provide 12 gage Type 316 stainless steel channel and accessories.
12. "C" beam clamps for hanger rods:
    a. Hanger Rods/Rods: Unistrut Corp or approved equal.
    b. All clamps shall be PVC coated with stainless steel rods.

2.3 HARDWARE FOR MOUNTING EQUIPMENT

A. Hardware for mounting equipment shall be high strength (100 percent rust resistant) and conform with the latest American Standards and Practices. Samples shall be submitted for approval. The Engineer will decide on one or more types and he will direct the Contractor to guide himself accordingly in the usage thereof at specific locations.

B. All anchor bolts shall be "Phillips Red Head Stud Anchor" type, or approved equal.

C. All screws and bolts shall be stainless steel with stainless steel nuts and washers where required.

D. Bolts, nuts and washers used for mounting fixtures shall be stainless steel and installed with proprietary screws to reduce vandalism. Heavy duty stainless steel flat washers and lock washers shall be provided with all screws and bolts. If required, and/or as shown on the drawings, equipment mounted in signal enclosures shall be attached to the walls, ceilings, floors, etc., of the enclosures by clamps as manufactured by "Unistrut" or approved equal.

E. "Everdur 651", or approved equal, hexagonal head machine screws, bolts and nuts with bronze flat washers shall be used for installing copper ground bus.

2.4 CONDUIT

A. Rigid hot-dipped galvanized steel conforming to the following:

1. Rigid galvanized steel conduit and fittings shall conform to the requirements of UL 6 and UL 1242, for threaded type, respectively, conforming to NEMA RN1, type A40, manufactured by Allied Tube and Conduit or Wheatland Tube Company, except that hardness shall be nominal 85 shore A durometer, dielectric strength shall be minimum 400 volts per mil at 60 Hz, tensile strength shall be minimum 3500 psi, and aging shall be minimum 1000 hours Atlas Weatherometer.

B. Polyvinyl chloride conduit, conforming to the following:

1. Polyvinyl conduit and fittings U.L. listed, rated for use with 90 degree C conductors and be Schedule 40. Materials shall conform to NEMA specifications TC-2 (conduit), TC-3 (Fittings) and UL 651 (conduit) and 514b (Fittings). Conduit and raceway shall carry a UL label stamped on each 10 length; markings shall be legible and permanent.
2. Conduit shall be made from polyvinyl chloride compound which includes inert modifiers to improve weatherability and heat distortion. Conduit and fittings shall be free of cracks, holes or foreign matter.
3. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity.

2.5 MATERIALS FOR HANDHOLES

A. Handholes are referred to throughout this section as "structures" or "underground structures". Handhole frames and covers shall be as shown on the Contract Drawings.

B. Brick shall be sewer and manhole brick conforming to ASTM C 32, grade MS.

C. Metal Frames and Covers: Provide cast steel frames and covers conforming to Fed. Spec. RR-F-621 except where rolled steel floorplate is indicated.

D. Handholes: Exterior handholes for platform area shall be designed and manufactured in accordance with ASTM C478 with additional stipulation that the concrete mix design shall be Class "A". Walls and base of handholes shall be reinforced concrete. Round frame and cover shall be #4.0 rated. Covers shall be cast with word "ELECTRIC" for power handholes and "COMM" for low voltage handholes. Covers shall be painted with stencil indicating handhole number. Numbering system shall be as directed by the owner. Handholes shall be provided with knocks on each wall. Provide with 1" PVC drain. Handholes for roadway lighting shall be Connecticut DOT Standard.

Exterior pullboxes cast into concrete shall be cast iron, size as indicated. Handholes shall be Connecticut DOT Standard conforming to Section 10.09 of CT DOT Standard Specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Attachment of Conduit System:

1. Masonry Construction: Attach conduit to masonry construction by means of pipe straps or pipe clamps and masonry anchorage devices.
2. Steel Beams: Attach conduit to steel beams by means of "C" beam clamps and hangers.

B. A bracket and channel type support of PVC coated galvanized steel construction shall be provided wherever required for the support of starters, switches, panels and miscellaneous equipment. Such supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework. Wherever this occurs, a pro vision shall be made for ready access to the wiring for connections to the equipment by means of boxes with screw covers.

C. Actual designs for supporting framework should take the nature of a picture frame of channels and bracket with a plate for mounting components. The Contractor is responsible for the design of supporting structure; he shall submit design details to the Engineer for acceptance before proceeding with the fabrication.

D. PVC coated galvanized steel support systems shall be utilized in all exterior areas.

E. The Contractor shall be responsible for the furnishing and installation of all conduit sleeves, anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.

F. If a time delay for the arrival of any special inserts, or equipment drawings, etc., occurs, the Contractor may, if permitted by the Engineer, make arrangements for providing approved recesses and openings in the concrete or masonry and upon subsequent installation the Contractor shall be responsible for filling in such recesses and openings. Any additional costs that may be incurred by this procedure shall be borne by the Contractor.

G. Where the weight of equipment exceeds 50 pounds and is supported from walls, ceilings, columns and/or beams, such supporting steel sizes, methods and locations shall be approved in writing by a Professional Engineer registered in the State of Connecticut.

3.2 UNDERGROUND CONDUIT FOR SERVICE FEEDERS

A. Underground conduit for service feeders from service pole to service equipment into buildings shall be hot-dip rigid galvanized steel.

B. The ends of the conduit shall be protected by threaded metal caps or bushings; the threads shall be coated with graphite grease or other suitable coating.

C. Conduit shall be cleaned and plugged until conductors are installed.

3.3 CONCRETE

A. Refer to Specification Division 03 for concrete requirements.

3.4 UNDERGROUND EXTERIOR SITE LIGHTING BRANCH CIRCUIT.

A. Underground exterior site lighting branch circuit wiring shall be installed in PVC Schedule 40 conduit, 24” below finished grade, except under paved areas raceways shall be rigid steel galvanized conduit, 24” below grade.

3.5 WARNING TAPES IN EARTH TRENCHES

A. For the purposes of early warning and identification during future trenching or other excavation, continuous identification tapes shall be provided in the trench above duct banks.

B. Tape shall be nonmagnetic plastic tape or aluminum foil plastic backed type manufactured for the purpose of early warning identification of utilities buried below the tape. Tape shall be at least 3 inches in width. Color of the tape shall be standard with the manufacturer for the type of utility buried below the tape.

C. Tape shall have lettering at least 1-inch high with not less than the following identification on the tape: "CAUTION BURIED (ELECTRIC) (TELEPHONE) LINE BELOW".

D. Tape shall be installed according to the printed recommendations of the tape manufacturer as modified herein. Tapes shall be buried at a depth of 6 inches below the top surface of earth; in pavements this 6 inches shall be measured from the top of the subgrade.

3.6 RECONDITIONING OF SURFACES

A. Unpaved surfaces disturbed during the installation of duct shall be restored to their original elevation and condition. Sod or topsoil shall be preserved carefully and replaced after the backfilling is completed. Sod that is damaged shall be replaced by

sod of quality equal to that removed. Where the surface is disturbed in a newly seeded area, the restored surface shall be reseeded with the same quantity and formula of seed as that used in the original seeding.

B. Paving Repairs: Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment or pavement shall be restored to the same thickness and in the same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces in a neat and acceptable manner

3.7 HANDHOLES

A. Underground structures shall be poured in place or may be of precast construction as specified hereinafter. Horizontal concrete surfaces of floors shall have a smooth trowel finish. Concrete shall be cured by applying 2 coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound shall conform to ASTM C309. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking. Covers shall fit the frames without under play. Steel and iron shall be formed to shape and size with sharp lines and angles. Castings shall be free from warp and blow holes that may impair their strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide all necessary lugs, rabbets, and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. The words "ELECTRIC" and "COMM" shall be cast in the top in all power and communications handhole covers, respectively. Handhole covers shall be provided with painted stencil indicating handhole number.

B. Optional Precast Concrete Construction: In lieu of poured-in-place concrete manholes and handholes, the Contractor may, at his option, provide precast concrete structures, subject to the requirements specified below. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes and handholes.

Precast concrete structures shall have the same accessories and facilities as required for poured-in-place structures. Likewise, they shall have plan area and clear heights not less than those of poured-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work shall have an ultimate 28-day compressive strength of not less than 4000 pounds psi. Structures may be precast to the design and details shown for poured-in-place construction, precast monolithically and placed as a unit; or, they may be of assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. All structures shall be identified with the manufacturer's name embedded in, or otherwise permanently attached to, an interior wall face.

C. Design for Assembled Units: Precast structures shall be designed in accordance with ACI 318 and shall be based on the following properties:

1. Angle of internal friction (0) = 30 degrees Unit weight of soil = 110 pcf.
2. Lateral at rest earth-pressure coefficient = 0.50.
3. Structure top and bottom shall be designed for full dead, superimposed dead, and live load including impact. Structure sidewalls shall be designed for lateral earth and hydrostatic pressures plus live load (H20 truck) adjacent to structure. Tops and walls of structures shall be designed for AASHTO standard H20 highway loading, with 30-percent loading added for impact, and with design load being that which produces maximum shear and moment. All dead and live loads, as well as impact loading, shall be considered in design. Walls shall be designed to withstand all soil pressures, taking into consideration the soil to be encountered and ground water level present at the site, and assuming that the H20 design vehicle will operate on surfaces adjacent to the structure. Ground water level shall be assumed to be 3 feet below ground surface unless a higher water table is indicated in the boring logs. Design shall also take into consideration stresses induced in handling units. Lifting devices shall be provided for properly handling units. Calculations and shop drawings shall be submitted covering the design and manufacture of precast units and shall bear the seal of a Registered Engineer in the State of Connecticut.
4. Mating edges of precast components shall be provided with tongue-and-grooved joints. Joints shall be designed to firmly interlock adjoining components and to provide waterproof junctions. Joints shall be sealed watertight using preformed plastic strip conforming to AASHTO M198, Type B. Sealing material shall be installed in strict accordance with the sealant manufacturer's printed instructions. Provisions shall be made for waterproofing cable entrances into structures and at covers in the top slab.

D. Metal Frames and Covers: Frames and covers of steel shall be welded by qualified welders in accordance with standard commercial practice. Steel covers shall be rolled steel floorplate having an approved antislip surface. Hinges shall be of wrought steel, 5 by 5 inches by approximately 3/16 inch thick, without screw holes, and shall be for full surface application by fillet welding. Hinges shall have nonremovable pins and 5 knuckles. The surfaces of plates under hinges shall be true after the removal, by grinding or other approved method, of raised lugs. Frames and covers shall be grounded as shown on Drawings.

3.8 EARTHWORK

A. Excavation for underground structures shall be to depths indicated. If hard material is encountered, the provisions of the Contract respecting an adjustment for changed conditions shall apply, subject to the requirements of notification thereunder being given. Hard material shall be defined as solid rock, firmly cemented unstratified masses, or conglomerate deposits possessing the characteristics of solid rock not

ordinarily removed without systematic drilling and blasting, and any boulder, masonry, or concrete (except pavement) exceeding 1/2 cubic yard in volume.

B. Excavated materials not required or suitable for backfill shall be removed from the project site. Provide sheeting and shoring as necessary for protection of work and safety of personnel. Remove water from excavation by pumping or other approved method.

C. Backfilling around structures shall consist of earth, loam, sand-clay, or sand and gravel, free from large clods of earth or stones over 1 inch in size. Backfill materials shall be placed symmetrically on all sides in loose layers not more than 9 inches deep. Each layer compacted with mechanical or hand tampers to 90 percent compaction, ASTM D698 density.

D. Backfilling Trenches: Backfill shall be placed in layers not more than 6 inches thick and each layer shall be compacted. Backfilling shall progress as rapidly as the construction, testing, and acceptance of the work permits. Backfill shall be free from roots, wood scrap material, and other vegetable matter and refuse. Compaction of backfill shall be to 90 percent of ASTM D698 density. The first layer shall be earth or sand, free from particles that would be retained on a 1/4-inch sieve and extending not less than 3-inches above the top of the cables. The succeeding layers shall be excavated material having stones no larger than would pass through a 4-inch ring. The backfill shall be level with the adjacent surface except that in sodded areas a space equal to the thickness of the sod shall be left

3.9 CONDUIT INSTALLATION

A. Conduit embedded in concrete shall be hot dip rigid galvanized steel.

B. Exposed conduit and fittings, on platform and wet locations shall be hot dip rigid galvanized steel with 40 mil PVC coating, color as selected by architect.

C. Conduit for underground exterior site lighting branch circuits shall be PVC Schedule 40, except under paved areas it shall be rigid steel galvanized conduit.

END OF SECTION 260529

SECTION 260533 RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section includes conduit, pull and junction boxes.

D. Related Sections:
1. Section 260526 - Grounding and Bonding for Electrical Systems.
2. Section 260529 - Hangers and Supports for Electrical Systems.
3. Section 260553 - Identification for Electrical Systems.

E. The Contractor shall supply, install, test and commission into service, all conduits indicated on the drawings.

F. The Contractor shall be responsible to obtain all existing conduit route details in the field to ensure that the new conduit routes can be accommodated and that all routes can be supplied and installed to fit existing conditions.

G. The Contractor shall provide new conduit route drawings for the new conduit routes being installed.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

C. Underwriters Laboratories, Inc. (UL):
1. 50, Enclosures for Electrical Equipment
2. 514A,B, Metallic Outlet Boxes and Fittings

1.3 SYSTEM DESCRIPTION

A. In Slab: Provide rigid steel conduit. Provide cast or nonmetallic metal boxes.

B. Wet and Damp Outdoor Locations: Provide PVC coated rigid steel conduit. Provide PVC coated cast metal outlet, junction and pull boxes. Provide flush mounting outlet box in finished areas.

C. Concealed Dry indoor Locations: Provide rigid steel. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

D. Exposed Dry Outdoor Locations: Provide PVC coated rigid steel conduit or rigid steel conduit. Provide PVC coated sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

1.4 DESIGN REQUIREMENTS

A. Minimum conduit size 3/4”.

1.5 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: Submit for the following:
1. Rigid steel conduit
2. Liquidtight flexible metal conduit.
3. Raceway fittings.
4. Conduit bodies.
5. Wireway.
6. Pull and junction boxes.

C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.8 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information

B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.9 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information

2.2 METAL CONDUIT

A. Manufacturers:
   1. Allied Tube and Conduit.
      Or
   2. Approved equal

B. PVC coated Rigid Steel Conduit: UL 6.

C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:
   1. Electri-Flex Company (Liquatite – Non-PVC).
      Or

2. Approved equal

B. Product Description: Interlocked steel construction with weather-tight PVC jacket. Per UL 1660

C. Fittings: NEMA FB 1.

2.4 PULL AND JUNCTION BOXES

A. Manufacturers:

1. OZ Gedney.
   Or
2. Approved equal.

B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

C. Enclosures: comply with NEMA 250 as follows:
1. Generally all areas and dry locations: NEMA 3R.
2. Damp locations: NEMA 4.
3. Wet locations: NEMA 4 or 4X.

D. Sizes shall provide sufficient space for pulling, racking, or splicing.

E. All boxes shall have covered secured with screwed or bolted fixings. Hinged covers shall not be provided.

PART 3 EXECUTION

3.1 PREPARATION

A. Transmit submittals required by this Section.

B. Furnish products as indicated.

C. Ensure substrates are in suitable condition to receive the work.

3.2 EXAMINATION

A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.3 EXISTING WORK

A. Not applicable

3.4 INSTALLATION

A. Ground and bond raceway and boxes in accordance with Section 260526.

B. Fasten raceway and box supports to structure and finishes in accordance with Section 260529.

C. Identify raceway and boxes in accordance with Section 260553.

D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.5 INSTALLATION - RACEWAY

A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.

B. Arrange raceway supports to prevent misalignment during wiring installation.

C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

D. Group related raceway; support using conduit rack. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports

E. Do not attach raceway to ceiling support wires or other piping systems.

F. Route exposed raceway parallel and perpendicular to walls.

G. Route conduit in and under slab from point-to-point.

H. Maintain clearance between raceway and piping for maintenance purposes.

I. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.

J. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations.

K. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams.

L. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

M. Install fittings to accommodate expansion and deflection where raceway crosses control and expansion joints.

N. Install suitable pull string or cord in each empty raceway except sleeves and nipples.

O. Install suitable caps to protect installed conduit against entrance of dirt and moisture.

P. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

3.6 INSTALLATION – BOXES

A. The location of all boxes shall be approved by the Engineer prior to completion of roughing-in. No final box locations will be permitted without this approval. No thru boxes shall be permitted.

B. Pull boxes and junction boxes shall be installed as required by NEC and in all runs of raceway having more than 100 feet in length or the equivalent of four (4) 90° bends; entirely accessible; #16 gauge galvanized steel up to 12″ × 12″ size and #10 gauge over 12″ × 12″ size; complete with covers of same gauge as boxes and secured to the box with screws; be securely mounted to building structure independent of the raceways connected to them. Pull boxes shall be indicated on the Contractor's Shop Drawings.

C. Install wall mounted boxes at elevations to accommodate mounting heights.

D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

E. Do not fasten boxes to ceiling support wires or other piping systems.

F. Install boxes in a secure, substantial manner, supported independently of raceway by attachment to the building structure or a structural member. Use bar hangers in frame construction, or fasten boxes directly with wood screws on wood, bolts and expansion shields on concrete or brick, toggle bolts on hollow masonry units and machine screws or welded threaded studs on steelwork. Threaded studs driven in by a powder charge and provided with lock washers and nuts are not acceptable in lieu of expansion shields. Boxes embedded in concrete or masonry need not be additionally supported. Utilize galvanized mounting hardware in battery room area.

G. Boxes installed in damp areas, and where specified shall be gasketed cast metal type having threaded hubs.

H. Mount all boxes plumb and level. Use flush-mounted boxes with concealed conduits. Make edges of boxes flush with finished surface. Provide proper type

extension rings or plaster covers for this purpose. For flush-mounted boxes, make holes in the surrounding surface no larger than required to receive the box.

3.7 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements

3.8 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION 260533

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. The extent of underground electrical work shall be as indicated on the drawings.

D. Section 260500 applies to this Section.

1.2 REFERENCE STANDARDS

A. American Concrete Institute (ACI)
- 315 Detailing Reinforced Concrete Structure
- 318 Building Code Requirements for Reinforced Concrete, including Commentary

B. American National Standards Institute (ANSI)
- C2 National Electrical Safety Code (NESC)

C. American Society for Testing and Materials (ASTM)
- B1 Hard Drawn Copper Wire
- B8 Concentric-Lay Stranded Conductors, Hard, Medium-Hard or Soft.
- C309 Liquid Membrane Forming Compounds for Curing Concrete

D. National Fire Protection Association (NFPA)
- 70-2005 National Electrical Code (NEC)

E. Underwriters Laboratories, INC. (UL)
- 6 Rigid Metallic Conduit
- 467 Grounding and Bonding Equipment.
- 510 Insulating Tape
- 514 Outlet Boxes and Fittings.

854	Service-Entrance Cables
1242	Intermediate Metal Conduit

1.3 GENERAL REQUIREMENTS

A. Electrical characteristics: Electrical characteristics for this project shall be 480/277 VAC, three phase, 4-wire, 60-hertz and 120/240 volt, single phase, 3 wire. Final connections to the system transformer made by the Contractor as directed by the supply company.

1.4 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer's Data:

1. Conduit
2. Splice Box
3. Insulating Tape
4. Terminator
5. Handhole frame and cover
6. Sealing material for precast manhole and handhole joints
7. Wire and cable

C. Shop Drawings:

1. Material description
2. Manufacturer's printed assembly and installation instructions. Drawing must be sealed by Connecticut State Professional Engineer.
3. Design calculations must be submitted and sealed by Connecticut State Professional Engineer.
4. Reinforcing shop drawings prepared in accordance with AC1-315.

D. Manufacturer's Instructions:

1. Manufacturer's instructions for use of ground megger with proposed method indicated.
2. Termination manufacturer's installation instructions.

E. Certificates:

1. Provide manufacturer's statement certifying that material and equipment supplied meets or exceeds specification requirements.
2. Handhole and accessories.
3. Cable splicer's certificate of competency.

1.5 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information

2.2 MATERIALS AND EQUIPMENT

A. Provide materials and equipment listed by UL or approved by Factory Mutual (FM) Systems when such is listed or approved.

2.3 TAPE

A. Plastic insulating tape shall conform to the requirements of UL 510 and ASTM Des. D119.

2.4 WIRE AND CABLE

A. Conductor and conduit sizes indicated for copper conductors shall bear the date of manufacture imprinted on the wire insulation with other identification. Wire and cable manufactured more than 6 months before delivery to the jobsite shall not be used.

B. Conductors rated 600 volts or less, including service entrances, shall conform to Section 260519.

C. Telephone Wire and Cable: Telephone cables shall conform to REA (BUL 345-14) (BUL 345-67) and Section 260519 and shall have the number of pairs indicated.

D. Pull Wire: Pull wire shall be plastic having a minimum tensile strength of 250 pounds shall be provided the entire length of all unused ducts. Minimum 12 inches of slack shall be left at each end of pull cord.

E. Connectors and Terminals: Connectors and terminals shall be designed and approved for use with the associated conductor material, and shall provide a uniform compression over the entire contact surface. Solderless terminal lugs shall be used on all stranded conductors.

2.5 GROUNDING

A. Grounding and bonding equipment shall conform to UL 467 and Section 260526. Ground rods shall be copperweld copper-clad steel with diameter adequate to permit driving to full length of the rod but not less than 1 inch in diameter and 10 feet long unless otherwise indicated. Ground rods shall be driven adjacent to each manhole and handhole or other concrete box.

2.6 CONDUIT AND FITTINGS

A. Rigid hot-dip galvanized Steel Conduit (Zinc-Coated): ANSI standard C80.1. Conduit shall be as manufactured by Wheatland Tube Company or Allied Tube & Conduit, or approved equal.

B. Flexible Metal Conduit: UL standard 1, zinc-coated steel only with liquid tight jacket.

C. Fittings for Rigid Hot-Dip Galvanized Metal Conduit, Electrical Metallic Tubing, and Flexible Metal Conduit: UL standard 514. Fittings for PVC coated conduit shall be PVC coated. All ferrous fittings shall be cadmium or zinc-coated per UL 514 as manufactured by Wheatland Tube Company or Allied Tube & Conduit or approved equal.

D. Fittings for rigid hot-dip galvanized metal conduit shall be the threaded type. Split couplings and cast conduit fittings are not acceptable.

E. Rigid galvanized steel, PVC-coated conduit, comply with NEMA RNI, shall be 40 mil dense polyvinyl chloride coating on exterior with cured 2 mil urethane interior. All fittings shall be of same finish. Conduit shall be as manufactured by OCAL, color as selected by Architect (special color to be selected.)

2.7 OUTLET AND DEVICE BOXES AND COVERS

A. UL standard 514, cadmium or zinc coated if of ferrous metal for exterior and platform outlet boxes and covers. Type "FS" or "FD" iron alloy and coated with 40 mils of PVC, interior of box shall be coated with 2 mil urethane and shall use Type 316 stainless steel screws for mounting, manufactured by Robroy Industries, Plastibond Series, or OCAL, Inc., or approved equal. Color as selected by Architect.

B. Sheet metal outlet and device boxes, NEMA OS1.

2.8 CABINETS, JUNCTION BOXES, WIREWAYS AND PULL BOXES (WITH VOLUME GREATER THAN 100 CUBIC INCHES)

A. Small sheet metal pull and junction boxes, NEMA OS1.

B. Metal wireways shall be UL listed and conform to NEMA 250, interior, Type 1, covers shall be screwed on. Finish shall be standard enamel.

C. Cast metal pull and junction boxes, NEMA FB1, cast-iron.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Underground installation shall conform to ANSI C2 and NFPA 70-2005, except as otherwise specified or indicated.

3.2 CONTRACTOR DAMAGE

A. The Contractor shall promptly repair any utility lines or systems damaged by his operations. Immediately notify the Engineer of any such damage.

3.3 CABLE PULLING

A. Raceways shall be tested with a mandrel and thoroughly swabbed out to remove foreign material before the pulling of cables. Cables shall be pulled down grade with the feed-in point at the handhole or buildings of the highest elevation. Flexible cable feeds shall be used to convey cables through the handhole opening and into the duct runs. Cable lubricants shall be soapstone, graphite, or talc for rubber or plastic-jacketed cables.

B. Lubricants for assisting in the pulling of lead, neoprene and polyethylene-jacketed cables shall be those specifically recommended by the cable manufacturer.

C. Cable pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer.

D. Secondary cable runs, 600 volts and less, shall include an insulated copper equipment grounding conductor sized as required by the rating of the overcurrent device supplying the phase conductors.

E. Installation of Cables in Handholes: Cables shall not be installed using the shortest route, but shall be routed along those walls providing the longest route and the maximum spare cable lengths. All cables shall be formed to closely parallel walls, not to interfere with duct entrances, and shall be supported on brackets and cable insulators at a maximum of 4 feet. Each cable shall be identified by corrosion resistant embossed metal tags attached in each underground structure in accordance with contract drawings and as approved by the Engineer. Each phase of the cable shall be identified.

3.4 CABLE TERMINATING

A. Terminations of insulated power and lighting cables shall be protected from accidental contact, deterioration of coverings, and moisture by the use of terminating devices and materials. Terminations shall be made using materials and methods as indicated or specified herein or as designated by the written instruction of the cable manufacturer and termination kit manufacturer.

B. Termination for cables shall be rated and be capable of withstanding test voltages, in accordance with the IEEE 48.

C. Terminations of single and multi-conductor cables shall include the securing and sealing of the sheath and insulation of the cable conductors, stress relief, and grounding of cable shields of shielded cable, and grounding of neutral conductors, metallic sheaths, and armor.

D. Cables and cable terminations shall be adequately supported so as to avoid any excessive strain on the termination and the conductor connection.

3.5 CONDUIT INSTALLATION

A. Service entrance conduit and conduit embedded in concrete shall be hot dip rigid galvanized steel.

B. Conduit and fittings, exposed conduit and fittings, on platform and wet locations shall be hot-dip rigid galvanized steel with 40 mil PVC and urethane interior coating, PVC color as selected by architect.

C. Interior conduit in dry locations shall be rigid galvanized steel.

D. Conduit for underground exterior site lighting branch circuits shall be PVC Schedule 40, except under paved areas it shall be rigid galvanized steel conduit.

E. Connections to vibrating equipment (including transformers) shall be liquidtight flexible metallic conduit.

F. Minimum conduit size shall be 3/4-inch, except for concealment of conduit to recessed light fixtures, switches, receptacle, and pull stations, where 1/2 inch conduit may be used. Home runs to panelboards shall not be less than 1-inch conduit. Conduit shall be installed in compliance with the NEC.

G. Unless indicated otherwise, all conduit shall be concealed within finished walls, ceilings, concrete walls and floors.

H. Keep conduit at least 12 inches away from parallel runs of water pipes.

I. Supports for Exterior Installations: Conduit shall be supported by Type 316 stainless steel wall brackets, hangers, (1 hole malleable iron pipe straps and clamp back) Fastenings shall be by Type 316 stainless steel toggle bolts on hollow masonry units; by concrete inserts or Type 316 stainless steel expansions bolts on concrete or brick; by Type 316 stainless steel, welded threaded studs, on steel work. PVC coated steel threaded C-clamps shall be used on 40 mil PVC coated rigid steel conduit. Conduit straps for PVC coated conduit shall be PVC coated. Conduits or pipe straps shall not be welded to steel structures. The load applied to fasteners shall not exceed one fourth of the proof test load. Fasteners attached to concrete ceiling shall be vibration and shock resistant.

J. Supports for Interior Installations: Conduit shall be supported by pipe straps, wall brackets, hangers, or ceiling trapeze. Fastenings shall be by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; by machine screws or welded threaded studs on steel work. Threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine or wood screws. Threaded C-clamps may be used on rigid steel conduit only. Conduits or pipe straps shall not be welded to steel structures. The load applied to fasteners shall not exceed one fourth of the proof test load. Fasteners attached to concrete ceiling shall be vibration and shock resistant. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete. Joints shall not cut the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws shall be used. In suspended-ceiling construction, conduit shall be run above the ceiling.

K. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall not be acceptable. Crushed or deformed conduit shall not be installed. Trapped conduits shall be avoided. Plaster, dirt, and trash shall be prevented from lodging in conduits, boxes, fittings, and equipment during construction. Clogged conduit shall be freed of all obstructions.

L. Empty conduit in which wire is to be installed by others shall have pull wires installed. The pull wire shall be of plastic having not less than 200-pound tensile strength. Not less than 12 inches of slack shall be left at each end of the pull wire.

M. Telephone and signal system conduit shall be installed in accordance with the previous requirements for conduit and with the additional requirements that no length of run shall exceed 100 feet for one inch or larger trade sizes, and shall not contain more than two 90-degrees bends or the equivalent. Pull and junction boxes shall be installed to comply with these requirements. Inside radii of bends in conduits 1 inch trade size and larger shall be not less than 10 times the nominal diameter.

N. Conduit installed in concrete floor slabs shall be located so as not to adversely affect the structural strength of the slabs. Conduit shall be installed within the middle one-third of the concrete slab. Conduit shall not be stacked. Conduits shall be spaced horizontally not closer than 3 diameters except at cabinet locations. Curved portions of bends shall be increased as necessary to provide a minimum 1 inch cover over conduit. Where conduits cross expansion joints, suitable watertight expansion fittings and bonding jumpers shall be provided. Conduit larger than 1-inch trade size shall be parallel to or at right angles to the reinforcement, the conduit shall be close to one of the supports of the slab. Conduit installed beneath floor slabs shall be encased in a minimum of 3 inches of concrete.

O. Conduits shall be fastened to all metal boxes and cabinets with two locknuts. Where insulated bushings are used and where bushings cannot be brought into firm contact with the box. at least two locknuts and bushing shall be used. Locknuts shall be the type with sharp edges for digging into the wall of metal enclosures. Bushings shall be installed on the ends of all conduits and shall be of the insulating type.

P. Conduits stubbed up through concrete floors for connections to free-standing galvanized equipment shall be provided with a short hot dip rigid galvanized steel conduit elbow for exterior installations. For interior installations, connections to free-standing equipment shall be provided with a short elbow and an adjustable brass top set flush with the finished floor. Screwdriver-operated or recessed-square-socket-type threaded flush plugs shall be installed in conduits from which no equipment connections are made.

Q. Flexible connections of short lengths shall be provided for equipment subject to vibration, noise transmission, or movement and for all motors. Liquidtight flexible conduit shall be used in all exterior locations. A separate ground conductor shall be provided across all flexible connections.

R. Flexible metal conduit in general shall be the same size as the branch conduit. Where necessary for recessing devices, 1/2 inch flexible metal conduit may be used. In special circumstances and with approval of the Engineer, 3/8 inch flexible metal conduit may be used where permitted by Articles 350-10 of the NEC and in conformance with local codes.

S. Installation of the flexible metal conduit shall comply with Article 350 and applicable provisions of Articles 300, 348 and 350 of the NEC.

T. Approved conduit expansion joints shall be provided wherever conduit crosses a structural expansion joint, is attached between two separate structures, and wherever the conduit run is 100 feet or more in a single straight length. Joints shall be O.Z. Gedney Type DX, Crouse Hinds Type XD or approved equal.

U. All conduit extending through the floor, behind panels or into control centers or similar equipment shall extend a minimum of 6 inches above the floor elevations, with no couplings at floor elevations, and shall be surrounded with a sealing bushing equal to O.Z. Gedney Type CSB.

V. Except as shown on the Contract Drawings the minimum size conduit permitted is 3/4 inch for exposed work and 1 inch for conduit encased in concrete or mortar.

W. Each piece of conduit installed shall be free from blisters and other defects. Each piece installed shall be cut square, taper reamed, and a coat of sealing compound applied to threads. Conduit connections shall be screwed tight with only incomplete threads exposed. All conduit joints shall be made with standard couplings and the ends of the conduit shall butt tightly into the couplings. In exposed work only, where standard couplings cannot be used, only Erickson couplings are permitted, or as otherwise acceptable to the Engineer.

X. Conduit threaded in the field shall have standard sizes and lengths.

Y. The equivalent number of 90° bends in a single conduit run are limited to the following.

- Runs in excess of 300 feet 0
- Runs of 300 feet to 201 feet 1
- Runs of 200 feet to 101 feet 2
- Runs of 100 feet and less 3

Factory bent elbows or field bent elbows made with approved tools may be used. Heating of conduit to facilitate bending is prohibited.

Z. All exposed conduit shall be installed either parallel or perpendicular to structural members, unless impractical, and shall be grouped wherever possible. Conduit shall be attached to structural components with approved supports spaced a maximum of five (5) feet apart and shall form a neat rigid installation. Conduit supported from building walls shall be installed with at least 1/4 inch clearance from the walls to prevent the accumulation of dirt and moisture behind the conduit. Provide PVC coated conduit spacers (clamp backs).

AA. Conduit and/or conduit fittings shall not be welded together or to any steel structure; however, conduit supports may be welded to flanges of steel beams, columns, etc., in accordance with approved welding techniques and engineering practice.

BB. Conduit installed in concrete or other masonry walls shall be so arranged that a minimum of 3 inches of covering is obtained. Spacings between conduits shall be sufficient to permit a complete filling with concrete or mortar without voids.

CC. The cutting of walls or floors for conduit shall be kept to a minimum. Where such cutting is absolutely necessary, care must be taken so as not to weaken the walls or floor involved. Beams or other structural supports shall not be cut under any condition. Holes through existing concrete slab must be core drilled.

DD. Conduit shall be protected immediately after installation by installing flat non-corrosive metallic discs and steel bushings, designed for this purpose, at each end. Discs shall not be removed until it is necessary to clean the conduit and pull wire and cable. Before wire or cable is pulled, insulated bushings shall be installed at each end of the conduit.

EE. Where all thread nipples are used between fittings and electrical equipment, they shall be so installed that no threads are exposed. All exposed threads shall be PVC coated.

FF. Connections from rigid conduit to motors, limit switches, solenoid valves, level controls, etc., shall be made with short lengths of liquid-tight flexible PVC jacketed metal conduit equal to Type "LA" Electri-Flex, Type "ULTRATITE" Alflex Corporation, or Type "VA" Annaconda. These lengths shall be provided with appropriate connectors with devices which will provide an excellent electrical connection between equipment and the rigid conduit for the flow of ground current.

GG. All threaded ends of conduits shall be coated with an approved conducting compound such as Thomas Betts "Kopr-Shield" compound prior to making up the point.

HH. All exposed conduits rising above finished floor elevation, excluding those encompassed by an equipment pad, shall be provided with a 4-inch high curb. Three (3) inches of cover shall be provided horizontally around the conduit. Conduits shall be PVC coated rigid steel.

II. Conduit passing through the walls and floors of buildings below grade shall be installed with appropriate watertight fittings to prevent the entrance of ground water around the periphery of the conduits. Conduits shall be sloped away from the buildings toward splice boxes, handholes and/or manholes to provide drainage away from the building wall. Conduits shall be encased in reinforced concrete with a minimum of 3" of cover over the conduit.

JJ. Conduit attachment to all electrical equipment, such as stainless steel junction boxes, pullboxes, switches, etc., shall be made with double steel locknuts. Threaded insulated bushings shall be used on the end of each conduit terminating in such equipment.

KK. Where plastic coated conduit and fittings are specified, plastic coatings damaged during transportation, loading, installation, etc., or cut during threading shall be repaired with the same type of covering obtained from and in accordance with the manufacturer's recommendations.

LL. Conduits passing through sleeves in walls and floors shall be tightly caulked. Sleeves shall be sealed to walls with expanding epoxy grout.

MM. When installing PVC conduit use only a vice approved for PVC conduit. The use of a chain vice will not be permitted.

NN. Conduit expansion fitting shall be equal to Crouse Hinds Type XD, OZ Gedney Type DX or equal for non-explosive areas.

OO. Conduit penetrating fire rated wall shall be provided with fire seals equal to OZ Gedney Type CFS.

PP. Conduit installation shall be arranged to minimize cleaning. No horizontal runs of conduit will be permitted in brick or masonry walls.

QQ. Conduits shall be supported with approved fittings. The support system shall not permit deflections to exceed 1/100 of the span.

RR. Conduit and ductsshall be caulked and sealed immediately after the wires and cables have been installed. The conduit bushings shall be thoroughly caulked with oakum, using wooden tools with rounded edges, and sealed with "Duxseal" waterproofing compound, Johns-Manville Corp. or approved equal. The compound shall be painted with one coat of approved insulated paint.

3.6 FURNISHING AND INSTALLING FERRULES AND FERRULE CONDUITS

A. Waterproof ferrules for electrical conduits shall be provided in the exterior walls, ceilings or floors of the enclosures. All waterproof ferrules for electric conduits shall be installed as directed by the client. The Contractor shall submit drawings showing method of installation.

B. Ferrules shall consist of extra heavy galvanized steel pipe with flanges set in the wall or floor of the enclosures, waterproofed with brick in mastic in an approved manner. Sufficient membrane waterproofing shall be provided to properly lap over the waterproofing of the existing structure and to act as a base for the brick-in-mastic. Membrane waterproofing shall consist of three layers of treated cotton fabric mopped with asphalt.

C. Steel feed conduits shall be provided through ferrules. The space between the conduit and the ferrule shall be caulked with oakum and lead wool. The conduit shall be encased in concrete and shall extend to locations indicated on the Contract Drawings.

3.7 BOXES, OUTLETS AND SUPPORTS

A. Boxes shall be provided in the wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Outlet and device boxes for PVC coated metallic raceways shall be of the cast-metal hub type coated with 40 mils of PVC, when located on platform or other wet locations. Each box shall have the volume required by the NEC for the number of conductors in the box. Boxes for mounting lighting fixtures shall be not less than 4 inches square or octagonal except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes installed for concealed wiring shall be provided with suitable extension rings or plastic covers, as required. Boxes for use in masonry-block or tile walls shall be square-cornered tile-type, or standard boxes having square-cornered tile-type covers.

B. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided. Boxes and pendants for surface-mounted fixtures on suspended ceilings shall be supported independently of the ceiling supports, or adequate provisions shall be made for distributing the load over the ceiling support members in an approved manner.

C. For Exterior Installations and Platform:

1. Outlet and device boxes shall be Type "FS" or "FD" PVC coated.
2. Junction and pull boxes shall be cast iron.
3. Boxes and supports shall be fastened with Type 316 stainless steel bolts and expansion shields on concrete or brick, with Type 316 stainless steel toggle bolts on hollow masonry units, and with Type 316 stainless steel machine screws or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts may be used in lieu of expansion shields, or machine screws. PVC coated cast-metal boxes having threaded connectors shall be supported directly from the building structure or by Type 316 stainless steel bar hangers. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved fastener not more than 24 inches from the box. Penetration into reinforced concrete members shall avoid cutting any reinforcing steel.
4. Boxes for use with raceway systems shall not be less than 1-1/2 inches deep except where shallower boxes required by structural conditions are approved. Boxes for other than lighting-fixture outlets shall be not less than 4-1/2 inches by 2-3/4 inches unless otherwise noted. Telephone outlets shall be a minimum of 4 inches by 2-3/4 inches by 1-1/2 inches deep.
5. Pull boxes of not less than the minimum size required by the NEC shall be cast iron boxes. Boxes shall be furnished with Type 316 stainless steel screw-fastened covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

D. For Interior Installations:

1. Boxes and supports shall be fastened on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts may be used in lieu of expansion shields, or machine screws. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved fastener not more than 24 inches from the box. Penetration into reinforced concrete members shall avoid cutting any reinforcing steel.
2. Boxes for use with raceway systems shall not be less than 1-1/2 inches deep except where shallower boxes required by structural conditions are approved. Boxes for other than lighting-fixture outlets shall be not less than 4 inches square except that 4-inch-by-2-inch boxes may be used where only one raceway enters the outlet. Telephone outlets shall be a minimum of 4 inches square by 1-1/2 inches deep.

3. Pull boxes of not less than the minimum size required by the NEC shall be constructed of code-gauge galvanized sheet steel except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastened covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.
4. Where conduits are connected to boxes or equipment enclosures through drilled holes or full size knockout openings, electrical continuity for grounding shall be assured by the use of bonding type locknuts or copper grounding wedges having set screws made up tight to bushings. Where connections are at eccentric or concentric knockouts, jumper type grounding bushings and wire jumpers shall be installed. At pull and junction boxes having any box dimension in excess of 18 inches and having a total of more than 4 conduit terminations, jumper type grounding bushings shall be installed on conduit ends and jumper wires shall be installed to bond all conduits and to bond conduits to boxes.
5. Should any structural difficulties prevent the setting of boxes at points shown on the plans, deviations therefrom as determined by the Engineer will be permitted and shall be made without additional cost.
6. A run of conduit between outlet and outlet, between fitting and fitting or between outlet and fitting shall not contain more than the equivalent of four quarterbends, including those bends located immediately at the outlet or fitting.
7. All junction boxes and pullboxes shall have identifying nameplates attached thereto, which when installed on sidewalk type boxes shall not extend above the surrounding concrete slabs.

E. Barriers: Galvanized steel barriers shall be provided in junction or pullboxes to isolate conductors of different voltages such as 480V, 120V, AC. The gauge of these barriers shall not be less than the gauge of the box required.

END OF SECTION 260543

SECTION 260548 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Seismic restraints for electrical equipment and systems.
3. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IBC: International Building Code.

C. IMC: Intermediate metal conduit.

D. NBC: National Building Code.

E. OSHPD: Office of Statewide Health Planning and Development.

F. RMC: Rigid metal conduit.

G. SBC: Standard Building Code.

H. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.

I. UBC: Uniform Building Code.

1.4 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
2. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings: Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a qualified professional engineer. Professional engineer qualification requirements as specified:

1. Fabricated Supports: Representations of field-fabricated supports not detailed on Drawings.
2. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:

a. Design Analysis to support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
b. Details:
Detail fabrication and arrangement.
Detail attachments of restraints to the restrained items and to the structure.
Show attachment locations, methods, and spacings.
Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Qualification Data: For testing agency.

F. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Comply with seismic-restraint requirements in the UBC unless requirements in this Section are more stringent.

C. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3

D. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.9 PROJECT CONDITIONS

A. Site Class as Defined in the IBC: C.

B. S_s, Mapped Maximum Considered Earthquake Spectral Response at Short Periods: 32.

C. S_1, Mapped Maximum Considered Earthquake Spectral Response at 1-Second Period: 9.

D. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 MANUFACTURERS

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the manufacturers specified below.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.3 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.

B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.

1. Available Manufacturers:
   a. Unistrut Co.
   Or
   b. Approved equal

2. Finishes:

   a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
   b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-3.
   c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-3.

3. Channel Dimensions: Selected for structural loading and applicable seismic forces.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Available Manufacturers:
   a. Cooper Industries.
   Or
   b. Approved equal

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
4. Rated Strength: Selected to suit structural loading and applicable seismic forces.

D. Raceway and Cable Supports: As described in NECA 1.

E. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of

conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Available Manufacturers:

        1) Hilti, Inc.
        Or
        2) Approved equal

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Available Manufacturers:

        1) Cooper Industries.
        Or
        2) Approved equal

3. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.4 SEISMIC-RESTRAINT COMPONENTS

A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least five times the maximum seismic forces to which they will be subjected.

B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.

C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.

1. Available Manufacturers:

a. Amber/Booth Company, Inc.
Or
b. Approved equal

2. Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.
3. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.
4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

2.5 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inchin diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
2. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION

A. Comply with NECA 1 for installation requirements, except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70-2005.

C. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.

D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and seismic criteria at Project.

B. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so expansion anchors will be a minimum of 10 bolt diameters from edge of the base.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

3.5 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS

A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Restraint Cables: Provide slack within maximums recommended by manufacturer.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.6 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Make flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing: Test pullout resistance of seismic anchorage devices.

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Record test results.

END OF SECTION 260548

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Provide identification as specified herein for all indicated items.

D. Work Included:

1. Nameplates to identify disconnect switches, starting devices, control switches, pushbutton stations, panelboards.
2. Wire tags at each end of all feeders and control wiring, and feeder wires only in all junction and pull boxes.
3. Labels for exposed conduits, conduits containing feeders, fire alarm and communications.
4. "DANGER-HIGH-VOLTAGE" signs shall be securely mounted on the entry doors of all electrical rooms and enclosures.
5. Provide OSHA, IEEE standard 1584, and NFPA-70E compliant Arc flash and shock hazard signage that indicates equipment voltage, all approach boundaries, incident energy levels, fault current levels available and PPE required for all electrical panelboards, safety switches, and transformers.

1.2 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1. Descriptive literature for materials specified.

1.3 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.6 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 MATERIALS

A. Nameplates:

1. Nameplates shall be black core, white laminated Micarta having engraved letters.
2. Letter size and nomenclature shall be as directed by DOT or Amtrak.

B. Labels:

1. Labels on fire alarm conduits shall consist of "FA" stenciled in red letters on a white painted rectangular background, ¾" high lettering.
2. Labels on communication conduits shall be 2 blue bands painted, each 1-inch wide with 1 inch between them.
3. Wire tags shall be of adhesive backed cloth material with printed identifying numbers and letters which come in strips of individual characters to be wrapped

around the conductor in sequence to comprise the identification. Nomenclature shall be as directed by client.

4. Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20 gage steel; of standard red, black and white graphics; 14 inches by 10 inches size except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision.
5. The conduits of all feeders and branch circuits shall be properly designated at all panelboards, switches and other equipment by an approved round yellow plastic tag, of 0.040-inch minimum thickness and one inch in diameter, Actioncraft Products, or approved equal. The lettering shall be black, 1/8-inch high. No. 18 monel wire, doubled, shall be used to secure the tag. A list of tag descriptions shall be submitted to the Engineer for approval before any lettering is done.
6. All conduits within enclosures shall be properly identified by Seton Nameplate Corporation "Setmark" markers, Brady Snap-On Pipe Markers, or approved equal. The lettering and color coding of the markers shall be black on an orange background or in conformance with the latest revision of the ANSI Z53.1 Scheme for Identification of Piping Systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. All surfaces to receive labels shall be carefully prepared in accordance with the manufacturer's instructions.

3.2 APPLICATION

A. Labels:

1. Labels shall be painted and stenciled on clean dry surfaces.
2. All conduit systems shall require identification when exposed or concealed above accessible ceilings.

B. Nameplates:

1. Nameplates shall be secured to painted surface with suitable Torx Tamperproof stainless steel screws, lockwashers and nuts.
2. Nameplates shall be secured to unpainted surfaces with epoxy cement. Surface shall be properly cleaned before application.

C. Danger Signs:

1. Danger signs shall be secured with Torx Tamperproof stainless steel screws lockwashers and nuts.

END OF SECTION 260553

SECTION 260800 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 GENERAL

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. All equipment furnished and installed under this Contract shall be tested as indicated in the Contract Drawings or as specified herein.

D. The Contractor shall hire an independent NETA certified testing company to make such tests as may be necessary to demonstrate that the equipment, as installed, complies with the Contract requirements. He shall provide all labor, instruments and apparatus required for such tests. If any of the equipment fails, under test, to meet the Contract requirements or to function properly, the defects shall be rectified by readjusting or removing and replacing, the faulty equipment until, under test, the requirements are met. The Engineer reserves the right to check the Contractor's instruments or to furnish his own instruments.

E. All tests shall be performed in conformity with the standard test codes of the applicable association(s) as specified in paragraph 1.2 FACTORY TESTS, and shall be witnessed by the Engineer or his representative and by an authorized representative of the User Department.

F. All measuring instruments shall be of the precision type and shall be calibrated immediately before and immediately after the tests. All instruments and other facilities, including labor, for the tests shall be provided by the Contractor. Client will furnish electrical energy to the Contractor without charge for making the tests.

G. The Contractor shall furnish and install all necessary testing apparatus such as calibrated meters, gauges, fittings, thermometers, etc. All apparatus supplied by the Contractor for these tests shall remain his property and be removed by him after the tests.

H. The Contractor shall submit test procedures for the approval of the Engineer, showing in complete detail the manner in which he proposes to perform each test.

I. Contractor shall provide full documentation and certifications of all tests performed.

1.2 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1.3 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.6 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.7 FACTORY TESTS

A. All equipment, including machinery, apparatus and materials of construction, shall be tested at the places of manufacture.

B. All service and distribution equipment, switchboards and panelboards shall be given a Hi-Pot test at the place of manufacture in accordance with the requirements of the latest edition of the National Electrical Code and witnessed by the Engineer or his authorized representative.

C. All necessary ratings, capacities, calibration, temperature in operation and other characteristics shall be obtained by methods in accordance with the standard test codes of the applicable association, such as the American National Standards Institute, Underwriters Laboratories, the Institute of Electrical and Electronics Engineers. Six copies of these certified ratings, etc., shall be submitted for the approval of the Engineer. No material or apparatus shall be shipped to the work site unless approved by the Engineer.

1.8 FIELD TESTS

A. Field tests shall be made on apparatus which is not assembled at the shop, such as electrical equipment, to demonstrate the soundness and suitability of the materials, and the adequacy of the craftsmanship of the installation work. In addition, performance tests shall be made on the plant as a whole, upon its major subdivisions and as required by the Engineer, in conformity with the standard test codes of the applicable association(s) as specified in Paragraph 1.2 FACTORY TESTS. All measuring instruments shall be of the precision type and shall be calibrated immediately before and immediately after the tests. All instruments and other facilities, including labor, for the tests shall be provided by the Contractor. The client will furnish to the Contractor, without charge, electrical energy for the tests.

B. The Contractor shall furnish and install all necessary testing apparatus such as calibrated electrical meters, gauges, fittings, thermometers, etc. All the foregoing apparatus supplied by the Contractor for these tests shall remain his property and be removed by him after the tests.

C. The Contractor shall submit, for the approval of the Engineer, test procedures showing in complete detail, the manner in which he proposes to perform each test.

D. All defects in the new systems shall be corrected to the satisfaction of the Engineer. All equipment shall be retested after the correction of defects.

E. The Contractor shall make insulation resistance and ground tests of all wiring installed under this Contract in conformity with the requirements of this Section and as elsewhere specified herein during the progress of the work, and at such time as the Engineer may desire. These tests shall be made previous to connection to equipment and in the presence of the Engineer.

F. Apparatus such as circuit breakers, contactors, motor starters, push button stations, etc., shall be checked for free movement and alignment of parts and contacts.

G. The ground fault protection system shall be performance tested, as required by the National Electrical Code, Article 230-95(c).

H. The grounding system shall be tested and verified with accepted methods and standards by actual measurements in the field. The proposed method of measurement shall be submitted for approval. Unless otherwise specified grounding resistance shall not exceed 5 ohms. The resistance values and the soil conditions at the time measurements were made, along with location of each ground rod shall be submitted to the Engineer.

I. A performance test shall be made to verify proper electrical operation of all power and control circuits and electrical apparatus.

J. After installation performance tests shall be made on the station as a whole, upon its major subdivisions and as required by the Engineer. The tests shall be performed with all rated loads connected.

K. Similar test shall be performed on the emergency equipment with all rated emergency loads connected.

L. Motors shall be checked for proper rotation, and for balancing of the currents in all three phases.

1.9 ELECTRICAL TESTS AFTER INSTALLATION

A. All electrical equipment, including wire and cable, shall be tested after completion of installation in accordance with the following specifications:

B. Wiring shall be installed so that when completed, the system will be free from shorts, crosses or grounds. All electrical feeders and other wire and cable prior to being connected as requested by the Engineer shall be subject to an insulation resistance test using a "megger" with the following D.C. voltages applied between the connected system and ground.

1. 250 volt system - apply 500 volts

C. Insulation Resistance: All wiring shall be so installed that when completed, the system will be free from shorts or grounds.

D. The Contractor shall make such tests as may be necessary, including polarity test of the sockets, to demonstrate that the equipment, as installed, complies with the Contract requirements. He shall provide all labor, instruments and apparatus required for such tests. If any of the equipment fails, under test, to meet the Contract requirements or to function properly, the defects shall be rectified by readjusting, or removing and replacing, the faulty equipment until, under test, the requirements are met. The Engineer reserves the right to check the Contractor's instruments or to furnish his own instruments.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. General: Extent of lighting control system work is indicated on drawings and schedules.

D. The extent of lighting control work includes, but is not limited to, the furnishing and installation of all lighting control components into complete and working lighting control systems as specified in this section, on the drawings, and as required by job conditions. System components include, but are not limited to:

a. Factory pre-assembled and pre-wired microprocessor controlled relay panels with electrically held, latched relay panels.
b. Control stations, including wall mounted low voltage remote controls.
c. Control system network low voltage wiring for interconnection of lighting control relay panels, remote switches and master control stations.
d. Digital Photosensor(s) for operation of selected circuits.
e. Interfaces to dimming systems.
f. Permanently installed terminal(s), Lighting Management Stations and master control stations for system programming and feedback.
g. Digital Time Clock (DTC)

1.02 DESIGN AND PERFORMANCE REQUIREMENTS

A. The submission of a bid by the Contractor will be construed as evidence that a careful, complete and thorough examination of the premises, existing job conditions and Contract Documents has been made and later

claims for labor, materials or equipment required or for difficulties encountered, which could have been foreseen had such an examination been made, will not be recognized. It shall also constitute a representation that the Contractor has checked and verified all quantities, work and materials involved and shall take complete responsibility for any deficiencies encountered thereafter.

B. The Contractor shall insure that the lighting control system manufacturer shall keep on file and make available for review by the Engineer and the Authority complete Quality Control and Quality Assurance records for all phases of production for all lighting equipment to be supplied under this project.

C. Upon request the Contractor shall submit for review by the Engineer and the Authority verification that he has solicited pricing from all manufacturers which have been listed as "prime spec" and "approved equal." Upon request the Contractor shall submit for review itemized (line item) unit equipment costs for all equipment to be provided under the Scope of this Contract.

D. The Contractor shall be solely responsible for coordinating and expediting the timely procurement and delivery for the lighting control system, equipment and related components for the project.

E. Specifications and drawings are intended to convey the salient features, function and character of the control system only, and do not undertake to illustrate or set forth every item or detail necessary for the work. Minor details not usually indicated on the drawings nor specified, but that are necessary or normally required for the proper execution, completion, installation and operation of the control systems shall be included, the same as if they were herein specified or indicated on the drawings.

F. Omissions: The full and complete responsibility for accurately fabricating the control systems described herein to the fulfillment of those specifications shall rest solely with the Contractor.

1.03 RELATED SECTIONS

A. Contract Documents: Drawings and General and Special provisions of the Contract, including bidding requirements, General Conditions, General Requirements of the Specifications apply to work of this section.

B. Related Sections: Refer to other sections of Division 26 for the following:

a. 260553 - Identification for Electrical Systems.
b. 260519 - Low Voltage Electrical Power Conductors and Cables.
c. 265200 - Emergency Lighting
d. 262726 - Wiring Devices
e. 265100 - Interior Lighting
f. 265600 - Exterior Lighting

1.04 REFERENCES

A. American National Standards Institute (ANSI)

a. C2 - National Electrical Safety Code

B. ASTM International (ASTM)

C. Illuminating Engineering Society of North America (IESNA)

D. National Equipment Manufacturers Association (NEMA)

a. WD6 - Wiring devices – Dimensional requirements
b. OD3 - Physical and electrical interchangeability of photo control devices and mating receptacles

E. National Fire Protection Association (NFPA)

a. 70 - National Electric Code
b. 101 - Life Safety Code

F. Underwriters Laboratories (UL)

G. Occupation Safety and Health Administration (OSHA)

a. The Energy Policy of 1992: Lamp Efficiency Labeling and Standards
b. The Energy Policy of 2005: Lamp Efficiency Labeling and Standards

H. Applicability of Standards:

a. Except where more explicit or stringent requirements are written into the Contract Documents, applicable construction industry standards have the same force and effect as if found in or copied directly into the Contract Documents. Such industry standards are made a part of the Contract Documents by reference.
b. Referenced standards (standards referenced directly in the contract documents) take precedence over standards that are not referenced but generally recognized in the industry for applicability to the work.

c. Unreferenced standards are not directly applicable to the work, except as a general requirement of whether the work complies with recognized construction industry standards.

I. Publication Dates: Except as otherwise indicated, where compliance with an industry standard is required, comply with the latest standard in effect as of date of Contract Documents.

J. Conflicting Requirements: Where compliance with two or more standards or criteria is specified and where these standards establish different or conflicting requirements for minimum quantities or performance quality levels, the most stringent requirement will be enforced, and henceforth provided by the Contractor unless the Contract Documents specifically indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent, to the Engineer for a decision before proceeding

K. Minimum Quantities or Quality Levels: In every instance the quantity or quality level shown or specified is intended to be the minimum to be provided or performed. Unless otherwise indicated, the actual work may either comply exactly, within specified tolerances, with the minimum quantity or quality specified, or may exceed that minimum within reasonable limits. In complying with these requirements, the indicated numeric values are minimum or maximum values, as noted or as appropriate for the context of the requirements. Refer instances of uncertainly to the Engineer for a decision before proceeding.

L. Copies of Standards:

a. The Contract Documents require that each entity performing work be experienced in that part of the work being performed. Each entity is also required to be familiar with industry standards applicable to that part of the work. Copies of applicable standards are not bound with the Contract Documents.
b. Where copies of standards are needed for proper performance of the work the Contractor is required to obtain such copies directly from the publication source.
c. Although copies of standards needed for enforcement of requirements may be required submittals, the Engineer reserves the right to require the Contractor to submit additional copies as necessary for enforcement of requirements.

1.05 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. All lighting control systems, components and sub-components shall be manufactured, furnished and installed in compliance with all government agencies having jurisdiction. All fixtures shall bear the appropriate UL (or ETL) and IBEW identifications. Panelboards and integral Lighting Control Chassis are to be UL listed under UL 916 Energy Management Equipment, UL 67 Panelboard Interiors and UL 5 panelboard box. Lighting control panels controlling emergency circuits shall be ETL listed to UL 924.

C. Manufacturers: Provide products of firms regularly engaged in the manufacture of lighting control equipment of the types and ratings whose products have been in satisfactory use in similar service for not less than ten years.

D. National Fire Protection Association (NFPA): Comply with NFPA 70, "National Electrical Code," as applicable to construction and installation of interior building lighting fixtures and emergency lighting.

E. Regulatory Requirements: Cabinets and all related components and subsystems shall comply with the following regulatory requirements:

a. National Electric Code (NEC)
b. National Electrical Manufacturer's Association (NEMA)
c. Underwriter's Laboratories, Inc. (UL) or (ETL)
d. Any local jurisdictional codes

F. Materials and equipment, as well as workmanship, shall conform to the highest commercial standards and shall be as specified and/or as indicated on the drawings. Parts not specifically identified shall be made of materials most appropriate for their intended use.

G. Manufacturers: Manufacturers shall be assumed capable of supplying the listed systems unless clearly written exceptions are set forth in their quotations. Any such exceptions shall immediately be brought to the attention of the Engineer. Manufacturers not listed (as prime or approved equal) must comply with the following:

a. Experience: Manufacturers shall have not less than ten years experience in design and manufacturing of lighting control equipment of the type and quality shown. Submission must include a list of completed projects and dated catalogue pages or drawings indicating length of experience.
b. Samples: Manufacturers shall submit a prototype sample of each panel and control equipment for review by the Engineer. Prototype samples shall be sufficiently detailed and operational to allow evaluation of compliance with the salient features of the

specification. Preliminary design or shop drawings shall not be accepted in place of prototype samples (see Section 1.08).

H. All major system components shall be manufactured and supplied by one company.

I. All components and assemblies are to be factory pre-tested and burned-in as a system for 48 hours prior to installation.

1.06 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: Submit manufacturer's data on panels, communication devices and controllers.

C. Shop Drawings: Submit dimensioned drawings of control system components. Submit shop drawings with proposed component and accessories clearly indicated on each sheet. Shop drawings must be submitted for review before fabrication. Shop drawings shall indicate the exact location of each device.

D. One Line Diagram: Submit a One Line Diagram of the Lighting Control System, indicating every component in the system and the type, size and number of conductors between each component. Submittals that show typical rise diagrams are not acceptable.

E. Manuals: Prior to final inspection, provide complete set of operating and maintenance manuals. Include technical data sheets and parts ordering information. Include testing and maintenance requirements and instructions for emergency transfer components.

F. Shop drawings shall be submitted in reproducible form. Fixture fabrication details shall be drawn at either full size or half size scale. Fabrication details shall illustrate a minimum of three critical views indicating all fabrication and assembly methods, materials, material gauges and finishes to be employed.

G. Catalogue submittals lacking sufficient detail to indicate compliance with contract documents shall not be acceptable.

H. "Approved Equal" specification status does not and shall not exempt the identified manufacturers from full and complete compliance with all criteria identified either in the specifications or as attributed to "prime specification" equipment with regards to performance, control capability, size finishes, etc. Consideration, acceptance or rejection of any proposed submittal at any time shall rest solely upon the evaluation of the Lighting Designer for those areas within the project scope. The control system shall be compatible with all selected light fixtures.

1.07 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.08 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.09 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information

B. The entire lighting control system shall carry a warranty for one year from date of start-up after final written acceptance by the Authority.

C. For the duration of the warranty the control system manufacturer shall provide 24-hour, 7-day emergency service contact with trained factory personnel. Maximum acceptable response time to a call for service shall be 12 hours. At the end of the warranty period, the manufacturer shall submit to the Authority a proposal for a continued maintenance contract for the entire control system.

D. The manufacturer of the control system shall guarantee that replacement parts for all new components shall be available for a minimum of seven years after the system's installation and acceptance by the Authority.

E. At the time of Bid Submission each manufacturer shall submit for review and approval the name of the person/persons or agency who will be

charged with the responsibility of fulfilling the manufacturer's field service obligations for the life of the warranty.

F. Warranty shall ensure that the Lighting Control System manufactured and supplied will be the kind and quality described in the specification and will be free of defects in workmanship and material.

1.10 SAMPLES

A. Upon request, submit for review one representative sample of each lighting control component required under this Contract. After sample acceptance, the control equipment shall be sent to the project for use as a standard. In the event the submission is rejected, the control component will be returned to the manufacturer who shall immediately make a new submission which meets the contract requirements.

B. Shipping: The samples must be actual working devices to be supplied and shall be submitted complete, ready for energizing and examining and shall be shipped (prepaid) to the Engineer or as otherwise specified or directed.

1.11 SUBSTITUTIONS

A. Equipment included under this section is specified by approved manufacturer, type, function to establish minimum standards of quality for bidding. Furnish equipment as specified unless substitutions are agreed upon as follows:

a. Submit a written Request for Substitution of Specified Equipment to the Construction Manager at least two weeks prior to bid date. Make the request an Alternate, separate proposal accompanied by complete descriptive and technical date in comparison to the "Accepted" manufacturers. Show cost comparison of "Accepted" manufacturer's equipment to the proposed substitution. Substitutions proposed less than two weeks prior to bid date, or not including proper documentation will not be considered.

b. Where proposed substitutions will alter the functional or visual design, or change the space requirements form those shown in the drawings, detail such changes in the proposal and include costs for revised design and construction for all trades involved.

c. No requested for substitutions will be considered more than ninety days after the contract is awarded.

d. If equipment to be supplied, including that supplied by approved manufacturers, meets the broad scope requirements of the drawings and specifications, but differed in some details, bring such

differences to the Authority's attention and obtain a written interpretation before submitting the bid, or proceeding with the work. Otherwise no variations or differences are permitted.

e. The Engineer approve/disapprove any requests for substitution.

PART 2 - PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 MANUFACTURERS

The approved manufacturer is shown below:

1. Acuity Brand/Lighting Control and Design, Glendale, California, 323 226-0000

   Or

2. Approved equal.

2.03 NETWORKABLE LIGHTING CONTROL SYSTEM DESCRIPTION

A. The lighting control system shall be a networked system that communicates via RS485. The system must be able to communicate with fully digital centralized relay panels, local relay panels, SO breaker panels, digital switches, photocells, various interfaces and shall include all operational software. The intent of the specification is to integrate all lighting control into one system, except for areas controlled by a single motion sensor such as some non public rooms and emergency fixtures designed to operate 24/7. Distributed lighting control shall be provided using networked lighting relay panels. Centralized relay panels shall control the station lighting and site lighting. Lighting control system shall include all hardware and software. Software shall be resident within the lighting control system. System shall provide local access to all programming functions at the master Lighting Control Panel (LCP) and remote access to all programming functions via dial up. Lighting control system shall have server built into the master LCP that “serves” HTML pages to any authorized workstation.

B. System software shall provide real time status of each relay, each zone and each group.

C. Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line all system

programming uploaded to the lighting control system shall continue to operate as intended. Systems requiring an on line PC or server for normal operation are not acceptable

D. All devices shall be pre-addressed at the factory. Field addressing is not acceptable.

E. All programs, schedules, time of day, etc, shall be held in non-volatile memory for a minimum of 10 years at power failure. At restoration of power, lighting control system shall implement programs required by current time and date.

F. System shall be capable of flashing lights Off/On any relay or any zone prior to the lights being turned Off. The warning interval time between the flash and the final lights off signal shall be definable for each zone. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and not exceed 2-hours.

G. The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, specification grade line voltage type wall switches, photocell, web based software or other devices connected to programmable inputs in a lighting control panel.

H. The Lighting Control System shall provide the ability to control each relay and each relay group per this specifications requirement. All programming and scheduling shall be able to be done locally at the master LCP and remotely via dial up modem and via the Internet. Remote connection to the lighting control system shall provide real time control and real time feedback.

I. System shall consist of centralized relay panels, local relay panels, Solenoid Operated (SO) breaker panels, digital switches, photocells and various digital interfaces. Verify exact components specified. Local relay panels, SO breaker panels, centralized relay panels and digital switches shall communicate as one network via RS485. Local relay panels, mounted in each local area, per plans shall control all lighting fixtures in that space, provide power to occupancy sensors and take input from daylight sensor and occupancy sensors. Local relay panels shall be capable of taking inputs from standard, line voltage type switches and outputting up to 8 independent 0v to 10v dimming signals. All local relay panels and all devices connected to local relay panels (switches, photocells and occupancy sensors, etc) shall be wired per lighting control manufacturers instructions.

2.04 MATERIALS AND COMPONENTS

A. RELAY PANELS

1. NEMA rated enclosures with screw cover or hinged door. Other NEMA enclosure types will be optional.

2. Lighting Control Panels (LCP) input power shall be capable of accepting 277V without rewiring.

3. Control electronics in the low voltage section shall be capable of driving 2 to 48, 30 Amp, 18,000 SCCR rated latching relays, control any individual or group of relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to current state, provide programmable blink warn timers for each relay and every zone, and be able to control relays that default to Open, Normally Open Latching (NOL) or relays that default to Closed, Normally Closed Latching (NCL).

4. Lighting control system shall be digital and consist of a Master LCP, Slave LCPs, Local LCPs with up to 8 individual relays, digital switches, digital interface cards and if required, SO breaker panels. All system components shall connect and be controlled via a single Category 5, 4 twisted pair cable with RJ45 connectors, providing real time two-way communication with each system component. Analog systems are not acceptable.

5. The lighting control system shall be a networked system that communicates via RS485 and includes centralized relay panels, local relay panels, digital switches, photocells, various interfaces and operational software. The intent of the specification is to integrate all lighting control into one system. Lighting control system shall include all hardware and software. Software to be resident within the lighting control system. System shall provide local access to all programming functions at the DTC and remote access to all programming functions via dial up modem. Lighting control system shall have server built into the master LCP that “serves” HTML pages to any authorized workstation.

B. LOCAL RELAY PANELS

1. Local relay panels shall have up to 8-30 Amp, 18,000 Short Circuit Rating (SCCR) rated lighting relays and shall control all lighting in the designated area indicated on the plans and be networked to centralized relay panels, local relay panels, SO breaker panels, digital switches, photocells, various interfaces. Each local relay panel shall provide minimum 300ma at 12/24vdc for powering occupancy sensors. Local relay panels that require a separate occupancy sensor power pack are not acceptable.

2. Local relay panel shall provide a minimum 4-programmable photocell inputs, a minimum 4-programmable occupancy sensor inputs and matrixed

contact closure inputs. This requirement is to insure integration of entire lighting system into one networked, lighting control system.

3. Local relay panels shall be capable of outputting minimum 4 and up to 8 independent 0v to 10v dimming signals, one independent dimming signal at each of 8 relays. In order to maximize daylight harvesting and minimize disruption to occupants, each dimming output shall provide adjustment for baseline, start point, mid point, end point, trim, fade up rate, fade down rate, time delay and enable/disable masking. All photocell setting must be remotely accessible. Systems providing On, Off with Time Delay only, and system that do not provide remote access are not acceptable.

C. STANDARD OUTPUT RELAYS

1. UL Listed 30 Amp, Latching, 18,000 SCCR, 277VAC Ballast and HID and 20 Amp Tungsten at 120 Vac.

2. Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two (2) #8AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable.

3. Relays to be rated for 250,000 operations minimum at a full 30 Amp lighting load, default to closed at normal power loss, Normally Closed Latching (NCL). All incandescent circuits shall be energized by use of a Normally Closed Soft Start relay rated at 100,000 operations at full 20 Amp load. No exceptions.

4. Optional relay types available shall include: Normally Open Latching (NOL) relay rated for 250,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

D. LOW VOLTAGE SWITCHES

1. All switches shall be digital and communicate via RS 485. Contact closure style switches, except as specified for connection to the local relay panel matrixed contact closure inputs, shall not be acceptable. The programming for a digital switch will reside in the switch itself, via double EPROM memory. Any digital switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.

2. Digital low voltage switch shall be a device that sits on the lighting control system bus. Digital switch shall connect to the system bus using the same

cable and connection method required for relay panels. System shall provide capability to locally and remotely program each individual switch button, monitor and change function of each button locally and remotely. Each button shall be capable of being programmed for On only, Off only, On/Off (toggle), Raise (Dim up) and Lower (Dim down). Switches requiring low voltage control wires to be moved from one input terminal to another to accomplish these functions are not acceptable.

3. Keyed switches shall be programmable and connect to the lighting controls system bus.

4. Digital switches for high abuse areas (public areas, etc.) shall be vandal resistant, contain no moving parts, and be touch sensitive and available with up to three buttons in a single gang. Multi gang versions shall also be available. Touch pads shall be Stainless Steel and capable of handling both high abuse and wash down locations. High abuse switches shall connect to the lighting control system digital bus. Each high abuse switch touch button shall be able to be control any relay or any group in any panel or panels that is part of the lighting control system. Each touch button shall be able to be programmed for On, Off, Toggle or Maintain operation. All programming shall be done locally or remotely via dial up modem; or web interface as described in other paragraphs of this section. High abuse switches shall be able to be enabled or disabled digitally. Each touch pad is to be identified as to function by an engraved label. Switches must be capable of handling electrostatic discharges of at least 30,000 volts (1cmspark) without any interruption or failure in operation.

E. DTC – DIGITAL ELECTRONIC TIME CLOCK

1. A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept interface inputs. DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.

2. The DTC shall be capable of controlling up to 126 digital devices on a single bus and capable of interfacing digitally with other individual busses using manufacturer supplied interface cards.

3. The DTC shall accept control locally using built in button prompts and use of a 8 line 21-letter display or from a computer or modem via an on-

board RS 232 port. All commands shall be in plain English. Help pages shall display on the DTC screen.

4. The DTC shall be run from non-volatile memory so that all system programming and real time clock functions are maintained for a minimum of 15 years with loss of power.

5. Pre-installed Unity™ lighting control software provides a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. System shall be capable of running optional Unity GX lighting control software, which shall provide for directly importing vector based graphics.

6. Pre-Installed modem allows for remote programming from any location using a PC. Modem to include all necessary software for local or remote control.
   DTC shall provide system wide timed overrides. Any relay, group or zone that is overridden On, before or after hours, shall automatically be swept Off by the DTC a maximum of 2 hours later.

F PHOTOCELL: Photocells shall be mounted in location indicated on the plans. Photocells used for exterior lights shall provide multiple trips point from 1 roof mounted unit. All trips points shall be able to be changed remotely via Internet or dial up modem. Photocells requiring manual trip point adjustment are not acceptable. Photocell used for interior lighting control shall have multiple settings such as start-point, mid-point, off-point, fade-up, fade-down, etc. All settings shall be remotely accessible and adjustable. Systems providing local adjustment only are not acceptable. Photocells to be certified to comply with the current energy code covering this project at time of submittal of plans for building permit.

G INTERFACES: For future expansion capability, system to have available all of the following interfaces. Verify and install only those interfaces indicated on the plans

.

1. A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card.

2. Interface card providing digital communication from one system bus to another system bus, allowing up to 12,000 devices to communicate.

3. Interface cards shall allow the DTC to control up to 32 digital XCI brand thermostats. Programming of thermostats shall be able to done locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet

.

4. Voice prompted telephone override interface modules shall be provided. Interface module shall accept up to 3 phone lines and allow up to 3 simultaneous phone calls. Voice prompted menu and up to 999 unique pass codes shall be standard with each interface module.

5. Software pre-installed to run Unity GX Graphical Interface Software. Unity GX software shall provide via local or remote PC a visual representation of a specific area or the total area of the project. GX full graphic pages shall be designed to the Authority's requirements.

6. Direct digital interface to SO Breaker panelboards shall be available. Relay panel and SO Breaker panelboards circuits shall appear on the system software as similar, yet distinct, items and maintain all functions and features of the system software.

7. Direct digital interface to DMX 512 based systems. DMX interface shall provide 14 global commands, each of which can be modified locally or remotely using lighting controls manufacturer supplied software. DMX interface shall be integral to the system bus and shall connect and be controlled via a single Category 5, 4 twisted pair cable, providing real time response from the lighting control system to DMX commands.

8. Direct digital interface to building automation systems using DDC protocols such as BACnet, Metasys (N2) and ModBus that accept on/off commands, time schedules and report status of all relays in all panels in real time. Interface cards shall "self populate" each individual relay and each group to the BAS. All BAS system programming required shall be the responsibility of the BAS system provider.

H. OCCUPANCY SENSORS:
TECHNOLOGY REQUIREMENTS

1. The occupancy sensor system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
2. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state; thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.

OPERATION REQUIREMENTS

1. Sensors shall offer a minimum on timer of at least 15 minutes, in order to prevent all cycling of lamps before they have burned for the lamp manu-

facturers minimum recommended time period. This timer shall be in addition to the regular occupancy time delay that keeps lights on after last detected occupancy. User shall be able to disable/enable and change the value of this timer

2. Sensors shall utilize an occupancy time delay that keeps lights on after last detected occupancy. Factory default setting of the occupancy time delay shall be 10 minutes. Sensors with a longer factory default setting shall not be permitted as they greatly restrict energy savings potential.

3. Sensors shall utilize an occupancy time delay that keeps lights on after last detected occupancy. Factory default setting of the occupancy time delay shall be 10 minutes
4. Installer, in accordance with manufacturer's recommendation, shall determine final sensor location. All sensors shall be factory calibrated for optimum performance for its installed PIR lens, and shall not require initial or subsequent field adjustment of detection sensitivity.
5. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

6. Combination photocell/dimming sensors shall accept 12 to 24 VAC or VDC from the relay panels and control the on/off function as well as the dimming function of 0 to 10 VDC dimmable drivers

7. Sensors shall be rated for indoor and outdoor conditions, based on the location shown on the drawings. They could be ceiling, wall or pole mounted for best switching result.
8. In high humidity or cold environments, the sensors shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit (and Celsius) operation.
9. All applicable products must be UL / CUL Listed or other acceptable national testing organization.
10. Sensors shall have a 5 year warranty.
11. Approved manufacturer shall be Sensor Switch, Inc. (800) 727-7483 www.sensorswitch.com or approved equal.

PART 3- INSTALLATION

3.01 INSTALLATION

A Delivery Storage Handling: Deliver products to the job site in manufacturer's original containers marked with job name, Contractor's name and labeling that

clearly indicates the contents. Deliver, store and handle products in accordance with manufacturer's written admonishments.

B. Job Conditions: Maintain job site conditions in accordance with manufacturer's recommendations.

C. Reject and do not install any damaged or unsatisfactory equipment. Replace unsatisfactory equipment with new equipment that is satisfactory if so directed by the Authority or their representative.

D. The system shall be installed utilizing complete manufacturer's shop drawings and in accordance with these specifications.

E. Install Control Stations only after "wet" work such as plastering and painting is complete and the area is cleaned.

F. The breaker cabinets and controls shall be stored in their original cartons or crates in a dry location free from dirt and dust until ready to install. Provide protection and protective coverings as appropriate to prevent damage to the equipment during installation and until Authority's acceptance. Repair or replace damaged equipment as directed.

G. Mount equipment at locations and heights indicated on approved shop drawings, or as directed by Authority. Locations indicated on the electrical drawings are general and approximate - carefully verify locations with Engineer's plans prior to installation. Check for adequacy of headroom and clearance with other equipment such as ducts, pipes and openings. The installing contractor shall bring all conflicts to the Authority's attention prior to proceeding with the work.

H. Upon completion of the installation Contractor shall test all line voltage and control wiring for continuity and accuracy of all connections.

I. Upon completion of the installation, the lighting control equipment shall operate per specifications and be free from defects in condition and finish. Moveable parts must operate freely and with uniform friction throughout their range. Any components damaged prior to the final inspection must be replaced by the Contractor prior to inspection.

J. Contractor shall ensure that the factory start up engineer makes any calibrations and adjustments necessary for proper operation of the system.

3.02 SYSTEM START-UP

K. Upon completion of the installation, the system shall be checked out and started up by a factory trained technician. Contractor to have completed and tested all wiring, installed all controls and lamped all fixtures before start up.

L. Upon completion of system start up, the factory trained technician shall demonstrate the operation of the system to the Contractor and the Authority's representative. Contractor to advise Authority's representative prior to scheduling start up so all persons designated by the Authority and Engineer are present for training. [See Sect. 3.03] The following system start-up services shall be supplied by a factory trained Technician during a single site visit.

a. Check installation of all Lighting Control Panelboards
b. Test operation of all Breakers and Lighting Breakers
c. Test operation of all Low Voltage Inputs
d. Test operation of all Telephone Override Lines
e. Test operation of all Network Communication
f. Test operation of the Associated Printers
g. Load Application Specific software Control Modules and test operation
h. Repair or replace any defective component
i. Test operation of the complete Lighting Management System

M. Equipment manufacturer to provide four bound copies of a "Maintenance and Operation Manual" to the Authority's representative. Manuals shall contain "As Built" shop drawings, wiring diagrams, description of all control functions, all instruction sheets for all components, calibration and adjustment procedures for all applicable components, maintenance procedures and instructions, component specifications, copy of warranty and service contract (if applicable), address and phone contacts for troubleshooting and service help. Manufacturer's start up engineer to review contents of manual with Authority's representative.

N. The Authority or his representative will schedule a final inspection with the Contractor. The Contractor will make any necessary adjustments and calibrations, whether the inspection is scheduled within or outside normal working hours, at no additional cost to the Authority.

O. If deficiencies that can be corrected immediately are apparent, correct them as soon as possible and schedule another final inspection with the Authority. The Contractor will reimburse the Engineer or his representative for his costs, including travel costs, to return for re-inspection. The Contractor will also bear costs of any additional

inspections until the system is approved of system. System must be approved prior to Authority's acceptance.

3.03 TRAINING

A. Factory technician will schedule, in coordination with the Authority, a training period for the Authority's staff [minimum five personnel] or designated appointees. This training period to be a minimum of three hours. Training to encompass entire scope of the system including operation, adjustments, maintenance and troubleshooting until completely understood. Manufacturer shall submit names and period of attendance of those instructed.

B. The following system training services shall be supplied by a factory Field Engineer during a single site visit:

a. System review of all Hardware Components and their functions
b. System review of all software Components and their function
c. Hands-On "Operator" training to develop experience with Supplied Control Functions
d. Hands-On "Building Engineer" training to develop experience with system Software Programming
e. Walk through of User's Guide and Programmer's Guide

3.04 SYSTEM PROGRAMMING

A. The following system programming services shall be supplied by a factory Field Engineer during a single site visit:

a. Advise the Building Engineer on developing a control scenario for each application
b. Program the Building Engineer supplied control scenario into the Lighting Management System
c. Review the programmed information with the Building Engineer and walk through the operation of the program
d. Provide program on a CD.

3.05 DOCUMENTATION

A. The following documentation shall be supplied:

a. System Single-Line Diagram: show system components and quantities including panelboards, breakers, low-voltage switches and sensors, dataline, telephone override lines and Lighting or Building Management Station.

b. Panelboard Configuration Diagram: Show PC board configuration, breaker configuration and power supply location.
c. Panelboard Wiring Schedule: Show breaker/load relationship with direct switch override if applicable.
d. Wiring Diagram: Show typical wiring application diagram for each system component supplied.
e. Installation Guide: Provide instructions as to how to install system components.
f. Manual: Provide User's Guide and Programmer's Guide in a loose leaf three ring binder with step by step illustrated instructions.
g. Riser Diagram: Provided by specifier along with reflected ceiling plans showing control schematic.

END OF SECTION 260923

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY:

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section Includes:

1. Distribution panelboards for station and platforms.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS:

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

D. Qualification Data: For qualified testing agency.

E. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Panelboard Schedules: For installation in panelboards.

H. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Standard Form 816 include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 CLOSEOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE:

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information

B. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

C. Handle and prepare panelboards for installation according to NEMA PB 1.

1.9 PROJECT CONDITIONS:

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F
b. Altitude: Not exceeding 6600 feet

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet

1.10 COORDINATION:

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.12 EXTRA MATERIALS:

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 GENERAL REQUIREMENTS FOR PANELBOARDS:

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
5. Finishes:

a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.
c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

6. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Compression type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals, contractor to submit short circuit calculations after selecting equipment.

2.3 DISTRIBUTION PANELBOARDS:

Manufacturers:

1. Eaton Cutler-Hammer
   Or
2. Approved equal.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 incheshigh, provide two latches, keyed alike.

D. Mains: Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices: Fused switches.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS:

A. Manufacturers:

1. Eaton Cutler-Hammer
   Or
2. Approved equal

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES:

A. Manufacturers:
   1. Eaton Cutler-Hammer
   2. Or
   3. Approved equal.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.

   4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
   7. Molded-Case Circuit-Breaker (MCCB) shall be bolt-on type.
      Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
      d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      e. Shunt Trip: 120 24-V trip coil energized from separate circuit, set to trip at 55 75 percent of rated voltage.
      f. All MCCB

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install freestanding panelboards on concrete bases, 4-inchnominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inchesabove finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

J. Comply with NECA 1.

3.3 IDENTIFICATION:

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with Division 26 Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING:

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION:

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262713 – ELECTRICITY METERING

PART 1 - GENERAL

1.1 SCOPE OF WORK:

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Furnish and install 480/277 volt, 3 phase, 4 wire 600A service entrance main/meter as shown on the drawings. Service entrance main/meter shall contain the main breakers and utility metering equipment as specified herein and as required to complete installation. Equipment shall be designed, manufactured and tested in accordance with the latest NEMA PB-2, UL 891 standards and NEC.

1.2 REFERENCE STANDARDS:

A. References shall be as specified in this Section.

1.3 QUALITY ASSURANCE:

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

C. It is the intent of these specifications that all components of the switchboards shall be provided by one vendor who shall have the sole responsibility of matching all components and providing equipment which functions together as a system.

1.4 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1. Shop Drawings
2. Preliminary Operation and Maintenance Manuals
3. Final Operation and Maintenance Manuals
4. Spare Parts List
5. Special Tools List
6. Reports of Certified Shop Tests

B. Each submittal shall be identified by the applicable Equipment Identification Number and Specification Section.

1.5 CLOSEOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 DELIVERY, STORAGE AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Contractor shall investigate spaces through which equipment must be moved. Arrange to have equipment shipped from manufacturer in crated sections of size suitable for moving through restricted available spaces.

1.7 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.8 SHOP DRAWINGS:

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submissions will be returned to the Contractor without review for re-submittal.

C. Equipment specifications and data sheets identifying all materials used and methods of fabrication.

D. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

E. Weights of all component parts, assembled weight of units and approximate total shipping weight.

F. Example equipment nameplate data sheet.

G. Interconnecting wiring diagrams.

H. List of recommended lubricants.

1.9 OPERATIONS AND MAINTENANCE MANUALS:

A. The Contractor shall submit operation and maintenance manuals.

B. Two copies of a preliminary O&M manual shall be included in the shop drawing submittal. Without inclusion of these manuals, the submittal will be considered incomplete and will be returned without review.

1.10 TOOLS, SUPPLIES, AND SPARE PARTS:

A. The panels and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment, all spare parts as recommended by the equipment manufacturer.

B. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "l lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.11 SERVICE OF MANUFACTURER'S REPRESENTATIVE:

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instructs the Contractor's personnel and the owner’s operating personnel in its maintenance and operation. The services of the manufacturer's representative shall be provided for the period of seven (7) field days. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer on each day he is at the project.

1.12 IDENTIFICATION:

A. Each unit of equipment shall be identified with the equipment item numbers given on the Contract Drawings, and in accordance with Section 260553. A corrosion resistant engraved Micarta nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, to complete identification.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 SERVICE ENTRANCE MAIN/METER:

A. General Construction: Service entrance main/meter shall be dead front type, completely metal enclosed, self-supporting structure independent of wall supports. Voltage rating shall be as indicated on the drawings. It shall consist of the required number of vertical sections bolted together to form one rigid switchboard. The sides and front shall be covered with removable screw-on plates. All edges of front cover panels shall be formed. Enclosures shall be of indoor ventilated NEMA Type I construction as shown on drawings.

Equipment shall comply with the latest applicable standards of NEMA PB2 and UL 891, comply with all NEC and UL requirements for service entrance and a UL service entrance label shall be provided. Metering compartment shall conform to U.I. requirements.

Service entrance main/meter shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and provided with contractor supplied floor sills to be set level.

Service entrance main/meter shall be manufactured by Cutler-Hammer/Eaton, or approved equal.

2.3 BUSSING:

A. All bus bars shall be silver plated copper with bolted connections at joints. The bus bars shall be of sufficient size to limit the temperature rise to 65 degree C rise based on UL tests, and rated to withstand mechanical forces exerted during short circuit

conditions when directly connected to a power source having an available fault current of 65,000 amperes symmetrical at rated voltages as shown on the drawings. Provide full capacity neutral.

B. A ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. An incoming ground lug shall be furnished. Other ground lugs for feeder circuits shall also be supplied as shown in the schedules on the drawings.

C. All hardware used on conductors shall be high-tensile strength and plated. All terminals shall be of the anti-turn solderless type suitable for copper cable of sizes indicated for 75 degree C cable.

2.4 UTILITY METERING:

A. Where indicated on the drawings, furnish a separate barriered-off Utility Metering Compartment complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers or potential taps as required by utility company. Provide Service Entrance Label and provide necessary applicable service entrance features per NEC and local code requirements.

2.5 MAIN PROTECTIVE DEVICES:

A. Main Breakers: Molded case circuit breaker shall be of quick-make, quick-break, trip free heavy-duty, 3 pole, 600 volts, with trip and frame ratings as shown on the drawings.

B. Devices shall have a minimum interrupting rating of 65,000 amperes at 480 volts.

C. Devices shall be manually operated (MO) or electrically operated (EO) as indicated on the drawings.

2.6 NAMEPLATES:

A. Engraved nameplates shall be furnished for all mains and feeder circuits with designation and circuit number as indicated on the drawings. Furnish Master Nameplate giving voltage, ampere rating, short circuit rating, manufacturer's name, general order number and item number.

2.7 FINISH AND PAINTING:

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 and use the manufacturer's standard process.

2.8 SHUNT TRIPS:

A. Provide circuit breaker with shunt trip units, as shown on One Line Diagram Drawings.

PART 3 - EXECUTION

3.1 GENERAL:

A. Install all electrical systems as indicated and in accordance with manufacturer's written instructions. All complete systems shall be in compliance with the National Electric Code and all state and local codes having jurisdiction.

3.2 PREPARATION:

A. Review installation procedures under other sections and contracts and coordinate them with the work specific herein.

B. Notify other contractors in advance of the installation of the work included herein to provide them with sufficient time for the installation and coordination of interrelated items that are included in their contracts and that must be installed in conjunction with the work included.

3.3 INSTALLATION:

A. Install the work of this section in strict accordance with the approved working drawings, the original design and all pertinent regulations and codes, anchoring all components firmly into position.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Snap switches.
3. Wall-switches.
4. Contactors.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

C. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

D. Samples: One for each type of device and wall plate specified, in each color specified.

E. Field quality-control test reports.

F. Operation and Maintenance Data: Wiring device manufacturers' packing label warnings and instruction manuals to be included.

1.5 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70-2005, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70-2005.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 MANUFACTURERS

A. Manufacturers' Names:

1. Cooper Industries, Inc.
   Or
2. Approved equal.

2.3 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 5352 (duplex).
      or
   b. Approved equal

2.4 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper;
      or
   b. Approved equal

2.5 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper;
      or
   b. Approved equal

C. Key-Operated Switches, 120/277 V, 20 A:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper;
      or
   b. Approved equal
3. Description: Single pole, with factory-supplied key in lieu of switch handle.

D. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper;
      or
   b. Approved equal

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Satin-finished stainless steel
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant equal to Pass & Seymour WICU-10.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required.

2.8 LIGHTING SWITCHES

A. Lighting control switches shall be furnished and installed as shown on the Contract Drawings.

B. Unless otherwise indicated on the Contract Drawings, the boxes for the switches shall be provided with cadmium plated sheet steel cover plates, Crouse-Hinds Co. Cat. No. DS32, or approved equal, for surface mounted boxes and Crouse-Hinds Co. Cat. No. DSS32, or approved equal, for flush mounted boxes.

C. Toggle Switches: UL standard 20, totally enclosed with bodies of thermosetting plastic and a mounting strap. Handles shall be ivory. Wiring terminals shall be of the screw type, back or side wired. Switches shall be rated quiet type with the number of poles, and other features indicated.

D. Pilot lights shall consist of yoke-mounted, candelabra-base sockets rated at 75 watt, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green and jewels for other purposes shall be white.

E. Lighting Contactors: Lighting contractors to be Square D Company or approved equal, Type S Series with NEMA I enclosure with hand-off auto selector switches.

F. All switches shall be mounted four feet above the finished floor, unless otherwise indicated on the Contract Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Light switches shall be mounted 48 inches above finished floor to centerline. Fire alarm pull stations shall be mounted 48 inches above finished floor to operating handle.

H. Receptacles, in general, shall be mounted 24 inches above finished floor except where unable, due to obstructions; receptacles may be mounted at a minimum of 18 inches above finished floor. Receptacles in the same room, space or area are required to be at the same elevation.

I. Heights given are from finished floor to centerline of outlet or devices

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Section includes: Cartridge fuses rated 600V ac and less for use in control circuits and enclosed switches.

1.2 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated.

C. Operation and maintenance data.

1.3 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.6 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Ind.
   or
2. Approved equal.

2.3 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

A. Motor Branch Circuits: Class RK1, time delay.

B. Other Branch Circuits: Class RK1, time delay.

C. Control Circuits: Class CC, fast acting.

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. This section specifies the furnishing and installation of safety switches complete in place.

1.2 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1. Manufacturer's catalog sheets for products should be included in this section.

1.3 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.6 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

B. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 SAFETY SWITCHES

A. Safety type disconnecting switches shall be Type "HD", heavy duty, Class 3, Design 3, unless otherwise indicated, mounted in NEMA I enclosures. Enclosures exposed to wet or rain conditions shall be NEMA 4X stainless steel, water tight. Switches shall be rated at 600 minimum volts or as required by the voltage of the circuit on which they are utilized. They shall be rated in horsepower, and each shall be capable of interrupting the locked rotor current of the motor for which it is to be used, which current will be assumed as ten (10) times the full rated load current.

B. The switches shall be of the quick-make, quick-break type, and all parts shall be mounted on insulating bases to permit replacement of any part from the front of the switch. All current-carrying parts shall be of high-conductivity copper, designed to carry rated load without excessive heating. Switch contacts shall be silver-tungsten type or plated to prevent corrosion, pitting and oxidation and to assure suitable conductivity. The switch operating mechanism shall be designed to retain its effectiveness with continuous use at rated capacity without the use of auxiliary springs in the current path.

C. Safety switches located at motors and which are used as disconnects for maintenance only, shall be unfused and capable of being locked in the open position.

D. Accessories:

1. Equipment ground kit, internally-mounted and labeled for copper and aluminum.

2. Auxiliary contact kit.

2.3 MOLDED-CASE CIRCUIT BREAKERS

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Cutler-Hammer
   Or
2. Approved equal

D. General Requirements: Bolt-on, Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

E. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

F. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

G. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
5. Auxiliary Contacts: Two SPDT switches] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 4X stainless steel.

2.5 NAMEPLATES

A. Standard phenolic nameplates with 3/8 inch minimum size lettering engraved thereon.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

END OF SECTION 262816

SECTION 263353 - STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY:

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. This Section includes the furnishing and installing of a three-phase, on-line, static-type, UPS installations, complete with transient voltage surge suppression, input harmonics reduction, rectifier-charger, battery, battery disconnect device, inverter, static bypass transfer switch and all accessories. UPS systems shall be installed for the station and platform lighting and communication racks.

1.2 DEFINITIONS:

A. EMI: Electromagnetic interference.

B. LCD: Liquid-crystal display.

C. LED: Light-emitting diode.

D. THD: Total harmonic distortion.

E. UPS: Uninterruptible power supply.

1.3 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: Include data on features, components, ratings, and performance for each uninterruptible power supply component indicated.

C. Shop Drawings: Detail assemblies of equipment indicating dimensions, weights, components, and location and identification of each field connection. Show access,

workspace, and clearance requirements; details of control panels; and battery arrangement.

1. Wiring Diagrams: Detail internal and interconnecting wiring; and power, signal, and control wiring. Differentiate between field-installed and factory-installed wiring and components.

D. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

F. Factory Test Reports: Comply with specified requirements.

G. Field Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

H. Maintenance Data: For UPS units to include in maintenance manuals. Include the following:

1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
2. Detailed operating instructions covering operation under both normal and abnormal conditions.

I. Warranties: Special warranties specified in this Section.

1.4 CLOSOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.5 QUALITY ASSURANCE:

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01

B. Installer Qualifications: An experienced installer who is an authorized representative of UPS manufacturer for both installation and maintenance of units required for this Project.

C. Power Quality Consultant Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET level 4, minimum, experienced in functional

performance testing UPS installations and in performing power quality surveys similar to that required in Part 3 "Functional Performance Testing" Article.

D. Manufacturer Qualifications: A firm who maintains a service center capable of providing training, parts, and emergency maintenance and repairs for equipment at Project site with eight hours' maximum response time.

E. Testing Agency Qualifications: An independent testing agency with experience and capability to conduct testing indicated without delaying the Work, as documented according to OSHA criteria for accreditation of testing laboratories, 29 CFR 1910.7; or a full member company of the International Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

F. Source Limitations: Obtain the UPS and associated components specified in this Section from a single manufacturer with responsibility for entire UPS installation.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70-2011, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

1. UPS Units: Listed and labeled under UL 1778.
2. Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information

B. Deliver equipment in fully enclosed vehicles after specified environmental conditions have been permanently established in spaces where equipment is to be placed.

C. Store equipment in spaces with environments controlled within manufacturers' ambient temperature and humidity tolerances for non-operating equipment.

1.7 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information

B. Warranties, General: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract

Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

C. Special Battery Warranties: Written warranty, signed by manufacturer and Installer agreeing to replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for Sealed Lead-Acid Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	6 cycles
30 minutes	30 minutes	1.67	20 cycles
15 minutes	1 minute	1.67	120 cycles

2. Warranted Cycle Life for Premium Sealed Lead-Acid Batteries: Equal or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	40 cycles
30 minutes	30 minutes	1.67	125 cycles
15 minutes	1 minute	1.67	750 cycles

3. Warranted Cycle Life for Wet-Cell Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.75	40 cycles
1 hour	1 hour	1.75	80 cycles
15 minutes	0 to 30 seconds	1.67	2700 cycles

D. Special UPS Warranties: Written warranties, signed by manufacturer and Installer agreeing to replace components that fail in materials or workmanship within special warranty period.

1. Special Warranty Period: Three years from date of Substantial Completion.

1.8 EXTRA MATERIALS:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to the client.

1. Fuses: One for every 10 of each type and rating, but not less than 1 of each.
2. Cabinet Ventilation Filters: One complete set.
3. One spare circuit board for each critical circuit.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information

2.2 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Deltec Corporation.
   or
2. Approved equal.

2.3 FUNCTIONAL DESCRIPTION:

A. Automatic operation includes the following:

1. Normal Conditions: Supply the load with ac power flowing from the normal ac power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies

energy to maintain constant, regulated inverter ac power output to the load without switching or disturbance.

3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated ac power to the load without switching or disturbance.
4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
5. If battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to a float-charge mode.
6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption of supply.
7. If a fault occurs in the system supplied by the UPS and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
9. If battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.

B. Manual operation includes the following:

1. Turning the inverter off causes the load to be transferred by the static bypass transfer switch directly to the normal ac supply circuit without disturbance or interruption.
2. Turning the inverter on causes the static bypass transfer switch to transfer the load to the inverter.

C. Maintenance Bypass/Isolation Switch Operation: Switch is interlocked so it cannot be operated unless static bypass transfer switch is in the bypass mode. Device provides manual selection between the following three conditions without interrupting supply to the load during switching:

1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.
2. Maintenance Bypass: Load is supplied, bypassing the UPS. UPS ac supply terminals are energized to permit operational checking, but system load terminals are isolated from the load.
3. Normal: Normal UPS ac supply terminals are energized and the load is supplied through either the static bypass transfer switch and UPS rectifier-charger and inverter, or the battery and the inverter.

2.4 SERVICE CONDITIONS:

A. Environmental Conditions: UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.

1. Ambient Temperature for Electronic Components: 32 to 104 deg F (0 to 40 deg C).
2. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).
3. Relative Humidity: 0 to 95 percent, noncondensing.
4. Altitude: Sea level to 4000 feet (1220 m).

2.5 PERFORMANCE REQUIREMENTS:

A. UPS shall perform as specified in this Article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:

1. Inverter is switched to battery source.
2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.

3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
5. Load is 30 percent unbalanced continuously.

B. Minimum Duration of Supply: If battery is sole energy source supplying UPS-rated full-output load current at 80 percent power factor, duration of supply is 4 hours, with ambient temperature between 68 to 86 deg F (20-30 deg C).

C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 20 percent from nominal voltage.

D. Overall UPS Efficiency: Equal to or greater than 80 percent at 100 percent load, 80 percent at 75 percent load, and 80 percent at 50 percent load.

E. Maximum Energizing Inrush Current: Eight times the full-load current.

F. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.

G. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.

H. Limitation of harmonic distortion of input current to the UPS shall be as follows:

1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5 percent, maximum, at full-rated UPS load current, for power sources with X/R ratio between 2 and 30.
2. Description: THD is limited to a maximum of 32 percent, at full-rated UPS load current, for power sources with X/R ratio between 2 and 30.

I. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.

J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent RMS total and 3 percent RMS for any single harmonic for rated full load with THD up to 50 percent, with a load crest factor of 3.0.

K. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of full-load rating for 10 minutes, and 150 percent for 10 seconds in all operating modes.

L. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:

1. 50 Percent: Plus or minus 8 percent.
2. 100 Percent: Plus or minus 10 percent.
3. Loss of AC Input Power: Plus or minus 5 percent.
4. Restoration of AC Input Power: Plus or minus 5 percent.

M. Input Power Factor: A minimum of 0.85 lagging when supply voltage and current are at nominal rated values and UPS is supplying rated full-load current.

N. EMI Emissions: Comply with FCC Rules and Regulations, 47 CFR 15 for Class A equipment.

2.6 SYSTEM COMPONENTS, GENERAL:

A. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

B. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

C. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

D. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect, static bypass transfer switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41, Category B.
2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.

E. Maintainability Features: Mount rectifier-charger and inverter sections and static bypass transfer switch on modular plug-ins, readily accessible for maintenance.

F. Capacity Upgrade Capability: Arrange wiring, controls, and modular component plug-in provisions to permit future 25 percent increase in UPS capacity.

G. Seismic-Restraint Design: UPS assemblies, subassemblies, and components; and fastenings and supports, mounting, and anchorage devices for them, shall be designed and fabricated to withstand static and seismic forces in any direction.

H. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of the cabinet and discharge it near the top rear.

I. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.7 RECTIFIER-CHARGER:

A. Capacity: Adequate to supply the inverter during full-rated output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Rectifier-Charger Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.

D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.8 INVERTER:

A. Description: Pulse-width modulated, with sinusoidal output.

2.9 STATIC BYPASS TRANSFER SWITCH:

A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.

B. Switch Rating: Continuous duty at the rated full-load current of the UPS, minimum.

2.10 BATTERY:

A. Description: Sealed, valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment of UPS cabinet, and complete with battery disconnect switch.

B. Description: Sealed, premium, heavy-duty, valve-regulated, recombinant, lead-calcium units, factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.

1. Arrange for drawout removal of battery assembly from cabinet for test and inspection.

C. Description: Wet-cell, lead-calcium, heavy-duty industrial units in styrene acrylonitrile containers mounted on three-tier, acid-resistant, painted steel racks. Assembly includes a battery disconnect switch, intercell connectors, a hydrometer syringe, and a thermometer with specific gravity-correction scales.

2.11 UPS CONTROL AND INDICATION:

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include an audible signal and a visual display.

C. Indications: Plain-language messages on a digital LCD or LED.

1. Quantitative indications shall include the following:
   a. Input voltage, each phase, line to line.
   b. Input current, each phase, line to line.
   c. Bypass input voltage, each phase, line to line.
   d. Bypass input frequency.
   e. System output voltage, each phase, line to line.
   f. System output current, each phase.
   g. System output frequency.
   h. DC bus voltage.
   i. Battery current and direction (charge/discharge).
   j. Elapsed time-discharging battery.

2. Basic status condition indications shall include the following:
   a. Normal operation.
   b. Load-on bypass.
   c. Load-on battery.
   d. Inverter off.
   e. Alarm condition exists.

3. Alarm indications shall include the following:
   a. Bypass ac input overvoltage or undervoltage.
   b. Bypass ac input overfrequency or underfrequency.
   c. Bypass ac input and inverter out of synchronization.
   d. Bypass ac input wrong-phase rotation.
   e. Bypass ac input single-phase condition.
   f. Bypass ac input filter fuse blown.
   g. Internal frequency standard in use.
   h. Battery system alarm.
   i. Control power failure.
   j. Fan failure.
   k. UPS overload.
   l. Battery-charging control faulty.
   m. Input overvoltage or undervoltage.
   n. Input transformer overtemperature.
   o. Input circuit breaker tripped.
   p. Input wrong-phase rotation.
   q. Input single-phase condition.
   r. Approaching end of battery operation.
   s. Battery undervoltage shutdown.
   t. Maximum battery voltage.
   u. Inverter fuse blown.
   v. Inverter transformer overtemperature.
   w. Inverter overtemperature.
   x. Static bypass transfer switch overtemperature.
   y. Inverter power supply fault.
   z. Inverter transistors out of saturation.

aa. Identification of faulty inverter section/leg.
bb. Inverter output overvoltage or undervoltage.
cc. UPS overload shutdown.
dd. Inverter current sensor fault.
ee. Inverter output contactor open.
ff. Inverter current limit.

4. Controls shall include the following:
   a. Inverter on-off.
   b. UPS start.
   c. Battery test.
   d. Alarm silence/reset.
   e. Output-voltage adjustment.

D. Dry-form "C" contacts shall be available for remote indication of the following conditions:

1. UPS on battery.
2. UPS on-line.
3. UPS load-on bypass.
4. UPS in alarm condition.
5. UPS off (maintenance bypass closed).

2.12 OUTPUT DISTRIBUTION SECTION:

A. Panelboard: Comply with Section 262416.

2.13 BASIC BATTERY MONITORING:

A. Battery Ground-Fault Detector: Initiates alarm when resistance to ground of positive or negative bus of battery is less than 5000 ohms.

B. Battery compartment smoke/high-temperature detector initiates an alarm when smoke or a temperature greater than 75 deg C occurs within the compartment.

C. Annunciation of Alarms: At UPS control panel.

2.14 BATTERY CYCLE WARRANTY MONITORING:

A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by a cycle-life warranty.

B. Basic Functional Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on integral LCD.

C. Additional monitoring functions and features shall include the following:

1. Measuring and Recording: Total voltage at battery terminals, providing alarm for excursions outside the proper float voltage level.
2. Monitors: Ambient temperature at battery and initiates an alarm if temperature deviates from normally acceptable range.
3. Keypad on Device Front Panel: Provides access to monitored data using front panel display.
4. Alarm Contacts: Arranged to provide local alarm for abnormal battery voltage or temperature.
5. Memory: Device stores recorded data in nonvolatile electronic memory.
6. RS-232 Port: Permits downloading data to a portable personal computer.
7. Modem: Makes measurements and recorded data accessible to remote personal computer via telephone line. Computer is not specified in this Section.

2.15 SOURCE QUALITY CONTROL:

A. Factory test complete UPS, including battery, before shipment. Include the following tests:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.
6. Efficiency test at 50, 75, and 100 percent of rated full-load current at rated power factor.

B. Observation of Test: Give 14 days advance notice of tests and provide opportunity for the client’s representative to observe tests at their option.

C. Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install system components on 4-inch- (100-mm-) high concrete bases. Cast-in-place concrete, reinforcing, and formwork are specified in Division 3.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70-2005.

C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams, unless otherwise indicated.

3.2 GROUNDING:

A. Comply with Section 260526 - Grounding for materials and installation requirements.

B. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70-2005 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.3 IDENTIFICATION:

A. Identify components and wiring according to Section 26 - Labeling and Identification.

1. Identify each battery cell individually.

3.4 BATTERY EQUALIZATION:

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.5 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage the services of a factory-authorized service representative to supervise UPS installation, startup, and preliminary testing and adjustment and to participate in final tests, inspections, and adjustments.

B. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each component of the UPS:

1. Inspect interiors of enclosures, including the following:

a. Integrity of mechanical and electrical connections.

b. Component type and labeling verification.

c. Ratings of installed components.

2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.

C. Electrical Tests and Inspections: Perform tests and inspections listed below by an independent testing agency meeting the qualifications specified in "Quality Assurance" Article according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS:

1. Inspect interiors of enclosures, including the following:
   a. Integrity of mechanical and electrical connections.
   b. Component type and labeling verification.
   c. Ratings of installed components.

2. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for the unit's rating. Use instruments calibrated, within the previous six months according to NIST standards.
   a. Simulate malfunctions to verify protective device operation.
   b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
   c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
   d. Test output voltage under specified transient-load conditions.
   e. Test efficiency at 50, 75, and 100 percent rated loads.
   f. Test remote status and alarm panel functions.
   g. Test battery-monitoring system functions.

D. Seismic-restraint tests and inspections shall include the following: Inspect type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.

E. Retest: Correct deficiencies and retest until specified requirements are met.

F. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.6 DEMONSTRATION:

A. Engage a factory-authorized service representative to train CTDOT (Amtrak) maintenance personnel to adjust, operate and maintain the UPS.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals.

3. Schedule training with client’s personnel, through Architect, with at least seven days advance notice.

3.7 FUNCTIONAL PERFORMANCE TESTING:

A. Monitoring and Testing Schedule: Perform monitoring and testing a single 10-day period.

1. Schedule monitoring and testing activity with client’s personnel, through Architect, with at least 14 days' advance notice.
2. Schedule monitoring and testing after Substantial Completion, when UPS is supplying power to its intended load.

B. Monitoring and Testing Instruments: Three-phase, recording power monitors. Instruments shall provide continuous simultaneous monitoring of electrical parameters at input terminals of the UPS and at input terminals of a load served by the UPS. Instruments shall monitor, measure, and graph voltage current and frequency simultaneously and provide full-graphic recordings of the values of those parameters before and during power line disturbances that cause the values to deviate from normal beyond the adjustable threshold values. Instruments shall be capable of recording either on paper or on magnetic media and have a minimum accuracy of plus or minus 2 percent for electrical parameters. Parameters to be monitored include the following:

1. Current: Each phase and neutral and grounding conductors.
2. Voltage: Phase to phase, phase to neutral, phase to ground, and neutral to ground.
3. Frequency transients.
4. Voltage swells and sags.
5. Voltage impulses, phase to phase, phase to neutral, phase to ground, and neutral to ground.
6. High-frequency noise.
7. Radio-frequency interference.
8. THD of the above currents and voltages.
9. Harmonic content of currents and voltages above.

C. Monitoring and Testing Procedure: As follows for each test period:

1. Exploratory Period: For approximately the first two days of the first scheduled monitoring and testing period, make recordings at various circuit locations and with various parameter-threshold and sampling-interval settings. Make these preliminary measurements with the objective of identifying optimum UPS, power system, load, and instrumentation set-up conditions for subsequent test and monitoring operations.
2. Remainder of Test Period: Perform continuous monitoring of at least two circuit locations selected on the basis of data obtained during exploratory period.
    a. Set thresholds and sampling intervals for recording data at values selected to optimize data on performance of the UPS with respect to values specified

in Part 2 of this Section, and to highlight any need to adjust, repair, or modify the UPS or any distribution system or load component that may influence its performance or that may require better power quality.

b. Perform load and UPS power source switching and operate the UPS on generator power during portions of the test period according to directions of client's Power Quality Consultant.

c. Operate the UPS and UPS loads in each mode of operation permitted by UPS controls and by the power distribution system design.

d. Create and simulate unusual operating conditions, including outages, voltage swells and sags, and voltage, current, and frequency transients that can be performed using loads and devices available as part of the facility's installed systems and equipment. Maintain normal operating loads in operation on system to maximum extent possible during tests.

e. Make adjustments and repairs to UPS, distribution, and load equipment to correct deficiencies disclosed by monitoring and testing and repeat appropriate monitoring and testing to verify success of corrective action.

D. Correlation with Specified UPS Monitoring Functions: Obtain printout recordings of built-in monitoring functions specified for UPS and UPS components in this Section that are simultaneous with those made with portable instruments in this Article.

1. Provide the temporary use of an appropriate personal computer and printer equipped with required connections and software for recording and printing if such units are not available on-site.
2. Correlate printouts with recordings for monitoring performed according to this Article, and resolve and report any anomalies in and discrepancies between the two sets of records.

E. Monitoring and Testing Assistance by Contractor: As follows:

1. Open UPS and electrical distribution and load equipment and wiring enclosures to make monitoring and testing points accessible for temporary monitoring probe and sensor placement and removal as requested.
2. Observe monitoring and testing operations and ensure UPS and distribution and load equipment warranties are not compromised.
3. Perform switching and control of various UPS units, electrical distribution systems, and load components as directed by Power Quality Consultant. The consultant shall design this portion of monitoring and testing operations to expose the UPS to various operating environments, conditions, and events while response is observed, electrical parameters are monitored, and system and equipment deficiencies are identified.
4. Make repairs and adjustments to the UPS and to electrical distribution system and load components, and retest and repeat monitoring as needed to verify validity of results and correction of deficiencies.
5. Engage the services of UPS manufacturer's factory-authorized service representative periodically through functional performance testing operations for repairs, adjustments, and consultations.

F. Documentation: Record test point and sensor locations, instrument settings, and circuit and load conditions for each monitoring summary and power disturbance recording. Correlate simultaneous recordings made on UPS input and load circuits.

G. Analysis of Recorded Data and Report: Review and analyze test observations and recorded data and submit a detailed written report. Include the following in report:

1. Description of corrective actions performed during monitoring and survey work and their results.
2. Recommendations for further action to provide optimum performance by the UPS and appropriate power quality for non-UPS loads. Include a statement of priority ranking and a cost estimate for each recommendation that involves system or equipment revisions.
3. Copies of monitoring summary graphics and graphics illustrating harmonic content of significant voltages and currents.
4. Copies of graphics of power disturbance recordings that illustrate findings, conclusions, and recommendations.
5. Recommendations for operating, adjusting, or revising UPS controls.
6. Recommendation for alterations to the UPS installation.
7. Recommendations for adjusting or revising generator-set or automatic transfer switch installations or their controls.
8. Recommendations for power distribution system revisions.
9. Recommendations for adjusting or revising electrical loads, or their connections or controls.

H. Interim and Final Reports: Provide an interim report at the end of each test period and a final comprehensive report at the end of the final test and analysis period.

END OF SECTION 263353

SECTION 264313 – SURGE PROTECTIVE DEVICES FOR LOW VOLTAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY:

A. Section Includes:

1. Distribution panelboards for station, platforms.

2. Lighting and appliance branch-circuit panelboards.

B. The Contractor shall furnish and install the Transient Voltage Surge Suppression (TVSS) equipment having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability, the AC surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway and/or motor control centers. Refer to related sections for surge requirements in:

1. Section 262416 – Panelboards

1.3 DEFINITIONS:

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS:

A. Seismic Performance: TVSS equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.5 REFERENCES

A. Electrical Codes: All electrical work covered by the Contract Documents shall conform to the requirements of National Electrical Code, 2011 Edition, state and other local codes.

B. Listings: All equipment and materials for which Underwriters' Laboratories, Inc. provides product listing service shall be Underwriters' Laboratories' approved and bear the U.L. Label

C. Standards: TVSS units and all components shall be designed, manufactured and tested in accordance with the latest applicable following standards:

1. National Electrical Manufacturers Association (NEMA).

2. Institute of Electrical and Electronic Engineers (IEEE).

3. American National Standards Institute (ANSI) ANSI/IEEE C62.41& C62.45.

4. Underwriters Laboratory (UL) Listed standards (UL 1449, & UL 1283)

1.6 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of transient voltage suppression device, accessory, and component provide verification that the TVSS device complies with this specification and UL 1449. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each panelboard and related TVSS equipment:

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Include evidence of NRTL listing for series rating of installed devices.

6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include wiring diagrams for power, signal, and control wiring.

8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

9. Provide actual let through voltage test data

10. Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 50 kHz and 200 kHz verifying the devices noise attenuation equal or exceeds 50 dB at 100 kHz

11. Provide test report in compliance with NEMA LS1 from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on both a per mode and per phase basis using the IEEE C62.41, 8 x 20 microsecond current wave. Note that test data on individual module is not accepted.

D. Seismic Qualification Certificates: Submit certification that TVSS and the panelboards, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.

1. Manufacturer's written instructions for testing and adjusting TVSS devices.

1.7 CLOSEOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.8 QUALITY ASSURANCE:

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.9 PROJECT CONDITIONS:

A. Environmental Limitations:

1. Do not deliver or install TVSS equipment until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F
   b. Altitude: Not exceeding 6600 feet

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet

1.10 COORDINATION:

A. Coordinate layout and installation of TVSS equipment and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.11 DELIVERY, STORAGE AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.12 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 GENERAL REQUIREMENTS FOR PANELBOARDS:

A. Electrical Requirements:

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.

2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall be greater than 115% of the nominal system operating voltage.

3. The suppression system shall incorporate a hybrid designed Metal-Oxide Varistors (MOV) surge suppressor for the service entrance and other distribution level. The system shall not utilize components that may crowbar the system voltage leading to system upset or create any environmental hazards.

4. Protection Modes – For a Wye configured system, the device must have directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For a Delta-configured system, the device must have suppression elements between line to line (L-L) and line to ground (L-G).

5. The maximum Suppressed Voltage Rating (SVR) per UL 1449 2nd Edition must not exceed the following:

Modes	208Y/120 & 120/240	240 Delta	480Y/277	480 Delta	600Y/347	600 Del-ta
L-N and/or L-G	400V	800V	800V	1500 V	1000V	2000V
N-G	400V	-	800V	-	1000V	-
L-L	800V	800V	1500V	1500 V	2000V	2000V

6. ANSI/IEEE Cat. C3 Let Through Voltage – The let through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Modes	208Y/120 & 120/240	480Y/277	600Y/347
L-N	550V	900V	1200V

B. TVSS Design:

1. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating TVSS modules shall not be acceptable.

2. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHz using the MIL-STD-220A insertion loss test method. Products not able to demonstrate noise attenuation of 50 dB @ 100 kHz shall be rejected.

3. Extended Range Filter – The Surge Protective Device shall have a High Frequency Extended Range Tracking Filter in each Line to Neutral mode with compliance to UL 1283 and NEMA LS1. The filter shall have published high frequency attenuation rating in the attenuation frequencies.

Attenuation Frequency	50kHz	100kHz	500kHz	1MHz	10MHz	100MHz
Insertion Loss (ratio)	40	316	316	89	200	79
Insertion Loss (dB)	32	50	50	39	46	38

4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.

5. Standard Monitoring Diagnostics – Each TVSS shall provide integral monitoring options:

   a) Each unit shall provide a green / red solid state indicator light shall be provided on each phase. The absence of a green light and the presence of a red light, shall indicate which phase(s) have been damaged.

   b) Audible Alarm – The TVSS shall provide an audible alarm with a reset pushbutton that will be activated under any fault condition.

   c) Event Counter – The TVSS shall be equipped with an LCD display system designed to indicate to the user how many surges, sags, swells and outages have occurred at the location. The event counter triggers each time under each respective category after significant event occurs. A reset pushbutton shall also be standard allowing all counters to be zeroed.

d) Push to Test – The TVSS shall be equipped with push-to-test feature, designed to provide users with real time testing of the suppressor's monitoring and diagnostic system. By depressing the test button, the diagnostic system initiates a self test procedure. If the system is fully operational, the self test will activate all indicator lights.

e) Voltage Monitoring – The TVSS shall display true Root Mean Square (RMS) on three L-N voltage protection mode on Wye configuration and three L-L voltage on Delta configuration.

6. Overcurrent Protection shall allow protection during high surge (kA) events with individually fused MOV's

7. The TVSS shall be immediately installed on the load side of the main breaker

8. A direct bus bar connection shall be used to mount the TVSS component to the panelboard bus bar to reduce the impedance of the shunt path

9. The TVSS shall be included and mounted within the panelboard by the manufacturer of the panelboard.

10. All monitoring diagnostics features shall be visible from the front of the equipment

C. Fabricate and test TVSS equipment according to requirements listed above.

D. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. All enclosed equipment shall be the same type enclosures as the panelboards, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Compression type.

3. Ground Lugs and Bus-Configured Terminators: Compression type.

F. TVSS Short-Circuit Current Rating: Fully rated to withstand symmetrical short-circuit current available at terminals.

2.3 TVSS MANUFACTURES:

A. Manufacturers: Eaton Electrical Inc.; Cutler-Hammer Business Unit or approved equal.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES:

A. Manufacturers: Eaton Electrical Inc.; Cutler-Hammer Business Unit or approved equal.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING:

A. Remove loose packing and flammable materials from inside TVSS, prevent condensation if stored outdoors.

B. Handle, store and prepare TVSS for installation in accordance with manufacturer's instructions, and NEMA PB 1.

C. Examine TVSS before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

3.2 INSTALLATION:

A. Install TVSS and accessories a per the manufacturer's recommendations and the contract drawings.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount plumb and rigid without distortion of box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.3 IDENTIFICATION:

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 TESTING:

A. Perform tests and inspections.

1. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NETA, NEMA and UL standards.

2. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. TVSS will be considered defective if they do not pass tests and inspections.

4. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 264313

SECTION 265100 – INTERIOR LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. The Contractor shall provide all lighting fixtures, labor, material, etc., in accordance with the preceding specifications, the requirements of this Section and as shown on the Contract Drawings.

D. Station towers and stairs and utility rooms light fixtures are included under this Section.

E. Lighting shall be in accordance with the Contract Drawings; and all lighting fixtures shall have the Underwriters' Laboratories label which indicates compliance with appropriate standards or performance in a specified manner.

F. All wiring shall be placed in conduit and shall comply with the specifications for conduits, outlet boxes, pull and junction boxes, wires and cables, grounding, etc., as set forth in these specifications and as noted herein.

G. The Contractor shall submit for approval, catalog cuts showing performance and construction details of standard fixtures and complete working drawings showing all proposed construction details for special or modified standard fixtures, and shall submit photometric curves.

H. Manufacturer's catalog number and description in the fixture schedule establishes quality, style, finish, etc. The Contractor shall provide pigtails and flexible conduit where required and connections to the outlet box. The use of catalog number describing the various types of fixtures shall be used as a guide only, and does not exclude all the required accessories or hardware that may be required for a complete installation.

I. Contractor shall accept responsibility for the coordination and proper relation of his work to the site lighting layout and to the work of all trades. Visit the premises and thoroughly familiarize himself with all details of the work and working conditions, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing any work.

J. Replace or repair defective equipment damaged in the course of installation or test.

K. Protect metallic materials against corrosion. All equipment intended for outdoor use shall be given corrosion-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with the earth, and where connected to dissimilar metal shall be protected by approved fittings and treatment.

L. Compliance of the above specification shall be done according to the following:

1. Ray-trace diagrams by computer graphics for each and every individual prism design for the lens shall be provided.

2. Photometric test for compliance must be performed by an independent testing laboratory.

3. Compliance of specifications must be certified by a registered Professional Electrical Engineer with at least 10 years experience in design of lens optics for luminaries.

4. Successful supplier must have at least 10 years experience in manufacturing of ornamental luminaries, and demonstrate successful installations in at least two major mass transit projects.

5. The Contractor shall not proceed with the manufacturer or installation of any lighting fixtures before approval is obtained.

6. The following engineering data for the fixtures to be installed under this Contract shall be submitted: distribution data and brightness characteristics of luminaire, photometric candle power charts for the mounting heights required, and as specified herein. If other fixtures than the ones specified in Contract drawings are used, recalculation of lighting levels will be required.

1.2 MANUFACTURERS

A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be

designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

1.3 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions. The following tests are required:

1. Witnessed Shop Tests: None required.

2. Field Acceptance Tests: Field tests shall be performed in accordance with requirements of Section 260800 Commissioning of Electrical Systems.

1.4 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1. Shop drawings and data for lighting fixtures. Drawings shall show types, size, accessories, installation details, and other details of construction. Data accompanying shop drawings shall include aiming diagram and computerized footcandle array.

2. Manufacturer's data for all fixtures indicating mechanical and electrical construction.

3. Certificates of conformance or compliance for the following:

4. Drivers should be as specified on the drawings or per manufacturer instructions, by a certified manufacturer with Underwriters' Laboratory Testing.

5. Certified laboratory test reports for the following:

6. Computerized candlepower distribution data taken in perpendicular plane in angles of every five degrees between 0 and 90 degrees. Data shall have a mean deviation of 10 percent and a maximum deviation of 20 percent.

7. Sample of each lighting fixture (one sample for each type).

B. Each submittal shall be identified by the applicable Equipment Identification Number and Specification Section.

1.5 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submissions will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Equipment specifications and data sheets identifying all materials used and methods of fabrication.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions.

3. Example equipment nameplate data sheet.

4. Interconnecting wiring diagrams.

5. All fixture photometric data.

1.6 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.8 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.9 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.10 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions.

1.11 TOOLS, SUPPLIES AND SPARE PARTS

A. The panels and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment, all spare parts as recommended by the equipment manufacturer and the following spare parts:

B. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and parts numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.12 IDENTIFICATION

A. Each unit of equipment shall be identified with the equipment item numbers given on the Contract Drawings. A corrosion resistant tag or nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, to complete identification.

1.13 REFERENCES

A. Section 260529 – Hangers and Supports for ES.

B. Section 265600 – Exterior Lighting.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 DRIVERS AND DIMMING CONTROLS

A. Drivers shall be selected as per lighting manufacturer instructions and shall be compatible with the lamps controlled.
B. LED Driver shall be installed inside an electrical enclosure; wiring inside enclosure shall comply with 600V/105°C rating or higher.
C. Shall be suitable for use in dry and damp locations

D. All lamps shall have dimming capabilities within 0-10v full-range; dimmer shall be suitable for LED lamps with maximum output voltage/minimum output current as per manufacturer instruction,

E. Manufacturers:

1. Acuity Brands
   Or
2. Approved equal

2.3 FIXTURES

A. Fixture wire shall be no. 10 AWG minimum

B. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be well rounded and free from chips or rough edges.

C. These fixtures are intended as ones subject to abuse, and damp locations, and as such shall bear listing with the Underwriters' Laboratories as a damp-location fixture, enclosed and gasketed. Electrical feeds shall be through hubs at the end of the fixture.

1. Vandal-resistant construction shall consist of a 0.125 inch minimum uninterrupted thickness, color corrective, acrylic lens, retained by concealed stainless steel spring-loaded fasteners and interlocking extrusions. Entire mechanism shall be concealed within the extruded outer housing, such that the tamper resistant stainless hardware is flush with the outer wall of the luminaire.

D. All fixtures shall be complete with hangers, supports, lamps, shielding, diffusers, insulation and all other accessories required for mounting and proper operation and shall have UL labels. Check architectural drawings to verify ceiling types and verify color of exposed trim and shielding medium with Engineer before ordering fixtures.

E. All fixture assemblies to be factory pre-wired to prescribed circuitry.

F. LED Fixtures: Except as otherwise indicated on the Contract Drawings, all lighting fixtures furnished and installed under this contract shall be as given in the Lighting Fixture Schedule or as shown on the Contract Drawings.

G. Lamp wattage shall be as indicated, and all fixtures shall be suitable for outdoor and vandal-resistant installation.

2.4 LAMPS

A. Color and temperature of LED lamps shall be as specified on schedule drawing

C. Contractor shall submit lighting calculations for levels of illumination once the fixtures have been selected.

2.5 ACCEPTABLE MANUFACTURERS

A. The Contractor shall provide fixtures as specified in the lighting schedule or approved equal.

2.6 LIGHTING CONTROL

A. Lighting control shall be as specified in 260923 Lighting Control devices

2.7 EXIT SIGNS

A. Exiting lighting units, with high impact housing and internal high output LEDs will be fed from the emergency panel via UPS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All lighting fixtures shall be installed in a neat and workmanlike manner and shall be mounted evenly and in line. Contractor shall determine the best location for fixtures and conduit runs. If, at any point, the construction will not permit the installation of the type of fixture shown on the Contract Drawings, the Contractor shall install a fixture of such type in such manner as directed by the Engineer. Where bracket fixtures are required, each fixture shall be adjusted to suit local conditions. Where pendant fixtures are required, approved suspension devices or rigid fittings shall be supplied and installed. Support pendant mounted fixtures with stems, 3/8" in diameter minimum, vertically attached to structural steel, concrete, beams, joists, and trusses. Contractor shall provide channel supports required to support the pendant fixtures. Wiring to pendant fixtures shall be run through the stem and iron bushing. All stem to box connections shall be secured with double nuts. All fixtures and hardware to be installed with Torx tamperproof screws. Stems for pendant fixtures shall be provided where necessary to make the height of all lamps uniform and in the same plane being dependent upon the minimum height of the ceiling in the areas indicated on the Contract Drawings. All steel and ceiling heights shall be verified in the field. All steel parts for the attachment of fixtures shall be hot-dip galvanized. Lead gaskets shall be provided between dissimilar metal mounting surfaces and metal to masonry interfaced.

B. The Contractor shall install, wire and illuminate five (5) fixtures for use as a test pattern to be approved by the client. Upon approval from client, the Contractor shall complete the remaining light fixtures installation.

C. All fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors and lamps.

D. Lighting fixtures location is subject to coordination with other trades and final location will be determine by the contractor and approved by the Engineer.

E. The Contractor shall provide and install all inserts, conduit, structural supports as required, wiring, etc., and properly adjust and test, to the satisfaction of the Engineer, the entire lighting system.

F. The Contractor shall protect all fixtures at all times from damage, dirt, dust, etc. Before final acceptance, all fixtures and devices shall be cleaned of all dust, dirt or other material, be fully relamped and in operating condition to the satisfaction of the Engineer.

G. Circuiting shall be as shown on the Contract Drawings and as follows:

1. Bus loads in all panelboards shall be balanced between phases to within a tolerance of one (1) kVA. Convenience receptacles shall be distributed evenly among all phase buses as much as practicable.

2. Voltage drop to the most remote lighting fixture shall be limited to 2 percent.

H. The Contractor shall supply all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hangers permitting normal fixture motion and self-alignment. Pendant lengths shall be adequate and adjusted to provide uniformity of installation heights above the reference datum. Stems shall be one piece, with matching canopies and fittings.

I. The Contractor shall provide recessed fixtures with a separate junction box concealed and located as to be accessible when fixture is removed.

J. All lighting units, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.

K. The Contractor shall install fixtures at mounting heights indicated or as instructed by the Engineer. In areas with exposed ducts and/or piping, installation of

lighting fixtures shall be adapted to field conditions as determined by the Engineer.

L. The Contractor shall support each fixture securely. Fixtures shall not be secured to the work of other trades, unless specified or noted otherwise, and shall not be supported to plaster. The Contractor shall furnish and install all steel members and supports as required to fasten and suspend fixtures from the structure and as specified by manufacturers instructions.

M. In all mechanical equipment areas, the Contractor shall install lighting fixtures on ceiling after all piping and equipment therein have been installed. Exact locations for such fixtures may be determined by the Engineer on the site during the course of the work.

N. Upon completion of work, and after the area is broom clean, all fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors, and lamps.

O. All fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of fixtures and/or lamps, as directed.

P. Relamping access shall require no special tools. All optical control surfaces such as lenses and reflectors shall be safely and securely attached to fixtures and shall be easily and quickly removed and replaced for cleaning without the use of tools. No fixture part that may be removed, for maintenance, shall be held in place by metal tabs that must be bent to remove said part.

Q. The Contractor shall install switches 4 ft. above the floor at the locations shown, and shall be single pole or double pole, as indicated.

R. All switches shall be enclosed in cast boxes and shall be furnished with waterproof, cast covers having external operating arms equal to Russell and Stoll, Appleton Electric or equal, for surface mounting. The Contractor shall provide all covers with rubber or neoprene gaskets.

S. Evenly proportion all fixtures in the room except where adjusted to conform with ceiling pattern as described below and where otherwise shown on drawings. Edges of the fixture shall be parallel with the walls.

T. All fixtures must hang true to vertical, free from finger marks, flaws, scratches, dents or other imperfections. Take care when hanging fixtures not to deface in any way, ceiling or walls.

U. Install continuous rows of fixtures in a straight line and at the same level. Fixtures must not be rotated about longitudinal axis with respect to one another. Mount surface fixtures tight to surface without distorting it. Provide proper mounting equipment for recessed fixtures to adapt them to the ceiling or wall construction and to prevent light leaks around trim. All stem mounted fixtures shall be hung level from self-aligning hangers in canopies.

V. Securely support all ceiling fixtures, hangers, and outlet boxes from structural members, not ceiling members. Plastic inserts are not permitted. Supports for each fixture shall be capable of supporting four times fixture weight.

W. Install fixtures at intersections of ceiling tile joints or centered on ceiling panels in rooms with acoustic tile or other patterned type of ceiling materials.

X. At acceptance of the work, the Contractor shall clean all fixtures and install new lamps. Contractor shall supply 10 percent spare lamps for all fixtures. Spare lamps shall be stored in the original manufacturer supply carton.

Z. Cables shall be installed in accordance with the requirements of NFPA 70. If paving or Railroad track is already in place wrought-iron or galvanized steel pipes shall be driven under it. Where rigid steel conduit installed underground without concrete encasement is indicated, the conduit shall have a factory-applied coating with minimum thickness not less than the following:

1.	Low-density or medium-density plastic	0.040-inch
2.	Epoxy resin	0.08-inch
3.	Coal-tar enamel	0.63-inch

3.2 FIELD TESTS AND INSPECTIONS

A. Perform all field tests and provide all labor, equipment, and incidentals required for testing, except when the client will provide electric power required for field tests when available.

B. After installation has been completed, the Contractor shall conduct an operating test. The equipment shall be demonstrated to operate in accordance with the requirements of this Section.

C. Show by demonstration in service that circuits, fixtures, and equipment are in good operating condition. Tests shall be such that each piece of control equipment shall function not less than 5 times. The Contractor shall give the Engineer 5 days advance notice of the dates and times for tests and inspections.

D. Interior installations shall be tested for insulation resistance after all wiring is completed and connected, ready for the attachment of fixtures and equipment, and again when fixtures and equipment are connected, ready for use. Test shall be as specified in Section 260800. All defective material and workmanship disclosed as the result of the tests given herein shall be corrected at no cost to the client. Demonstrate in service that all circuits and devices are in good operating condition.

E. Deficiencies shall be rectified and work affected by such deficiencies shall be completely retested at the Contractor's expense.

END OF SECTION 265100

SECTION 265200 EMERGENCY LIGHTING

PART 1 GENERAL

1.1 SUMMARY

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. Section includes emergency lighting units and exit signs.

D. Related Sections:
1. Section 260526 - Grounding and Bonding for Electrical Systems.
2. Section 260533 - Raceway and Boxes for Electrical Systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association:
1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

B. Underwriters Laboratories, Inc. (UL):
1. UL 924 Listed (Emergency Lighting).

1.3 SYSTEM DESCRIPTION

A. Emergency lighting to comply with requirements of NFPA 101 and IESNA Illumination Guide – Transportation and Facilities Sections.

B. Station: Emergency lighting fixtures will be supplied from the UPS making sure that the illumination level on the egress path will not be under 1fc.

C. Exit signs shall be located as per NFPA 101 and shall be continuous illuminated to mark the means of egress.

1.4 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: Submit dimensions, ratings and performance data.

1.5 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.

1.7 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.8 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.9 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 EXIT SIGNS

A. Manufacturers:
   1. Dual Light
      or
   2. Approved equal.

B. Product Description: Exit sign fixture, injection-model, flame retardant, high impact construction with LED lamp, directional arrows and universal mounting kit

C. Input Voltage: 277 volts.

D. Directional Arrows: As indicated on Drawings

2.3 FLUORESCENT LAMP EMERGENCY POWER SUPPLY

A. See Section 263353 – Static Uninterruptible Power Supply

PART 3 EXECUTION

3.1 INSTALLATION

A. Install suspended exit signs using pendants supported from swivel hangers. Install pendant length required to suspend sign at indicated height.

B. Install surface-mounted emergency lighting units and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

C. Install wall-mounted emergency lighting units and exit signs at height as indicated in manufacturer literature

D. Install accessories furnished with each exit sign.

E. Connect emergency lighting units and exit signs to branch circuit supplied by UPS

F. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within unit.

G. Ground and bond emergency lighting units and exit signs in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. Field inspecting, testing, adjusting, and balancing.

B. Operate each unit after installation and connection. Inspect for proper connection and operation.

3.3 PROTECTION OF FINISHED WORK

A. Re-lamp emergency lighting units and exit signs having failed lamps at Substantial Completion.

END OF SECTION 265200

SECTION 265600 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. The Contractor shall provide all lighting fixtures, labor, material, etc., in accordance with the preceding specifications, the requirements of this Section and as shown on the Contract Drawings.

D. Outdoor tower lighting and platform fixtures are included under this Section.

E. Lighting shall be in accordance with the Contract Drawings and all lighting fixtures shall have the Underwriters' Laboratories label which indicates compliance with appropriate standards or performance in a specified manner.

F. All wiring shall be placed in conduit and shall comply with the specifications for conduits, outlet boxes, pull and junction boxes, wires and cables, grounding, etc., as set forth in these specifications and as noted herein.

G. The Contractor shall submit for approval catalog cuts showing performance and construction details of standard fixtures and complete working drawings showing all proposed construction details for special or modified standard fixtures, and shall submit photometric calculations.

H. Manufacturer's catalog number and description in the fixture schedule establishes quality, style, finish, etc. The Contractor shall provide pigtails and flexible conduit where required and connections to the outlet box. The use of catalog number describing the various types of fixtures shall be used as a guide only, and does not exclude all the required accessories or hardware that may be required for a complete installation.

I. Contractor shall accept responsibility for the coordination and proper relation of his work to the work of all trades. Contractor will visit the premises and

thoroughly familiarize himself with all details of the work and working conditions, verify all dimensions in the field and advise the Engineer of any discrepancy before performing any work.

J. Replace or repair defective equipment damaged in the course of installation or test.

K. Protect metallic materials against corrosion. All equipment intended for outdoor use shall be given corrosion-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with the earth, and where connected to dissimilar metal shall be protected by approved fittings and treatment.

L. Compliance of the above specification shall be done according to the following:

1. Ray-trace diagrams by computer graphics for each and every individual prism design for the lens shall be provided.

2. Photometric test for compliance must be performed by an independent testing laboratory.

3. Compliance of specifications must be certified by a registered Professional Electrical Engineer with at least 10 years experience in design of lens optics for luminaries.

4. Successful supplier must have at least 10 years experience in manufacturing of ornamental luminaries, and demonstrate successful installations in at least two major mass transit projects.

5. The Contractor shall not proceed with the manufacturer or installation of any lighting fixtures before approval is obtained.

6. The following engineering data for the fixtures to be installed under this Contract shall be submitted: distribution data and brightness characteristics of luminaire, photometric candle power charts for the mounting heights required and as specified herein. If other fixtures than the ones specified in Contract drawings are used, recalculation of lighting levels will be required.

1.2 MANUFACTURERS

A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Contract Drawings.

1.3 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions. The following tests are required:

1. Witnessed Shop Tests: None required.

2. Field Acceptance Tests: Field tests shall be performed in accordance with requirements of Section 260800 Commissioning of Electrical Systems.

1.4 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Submit the following:

1. Shop drawings and data for lighting fixtures. Drawings shall show types, size, accessories, installation details, and other details of construction. Data accompanying shop drawings shall include aiming diagram and computerized footcandle array.

2. Manufacturer's data for all fixtures indicating mechanical and electrical construction.

3. Certified laboratory test reports for the following:

Computerized candlepower distribution data taken in perpendicular plane in angles of every five degrees between 0 and 90 degrees. Data shall have a mean deviation of 10 percent and a maximum deviation of 20 percent.

5. Sample of each lighting fixture (one sample for each type).

B. Each submittal shall be identified by the applicable Equipment Identification Number and Specification Section.

1.5 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.7 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

1.9 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submissions will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Equipment specifications and data sheets identifying all materials used and methods of fabrication.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions.

3. Example equipment nameplate data sheet.

4. Interconnecting wiring diagrams.

5. All fixture photometric data.

1.10 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions.

1.11 TOOLS, SUPPLIES AND SPARE PARTS

A. The panels and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment, all spare parts as recommended by the equipment manufacturer.

B. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and parts numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.12 IDENTIFICATION

A. Each unit of equipment shall be identified with the equipment item numbers given on the Contract Drawings. A corrosion resistant tag or nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, to complete identification.

1.13 REFERENCES

A. Section 260529 – Hangers and Supports for ES.

B. Section 265100 – Interior Lighting.

1.14 CODES, LISTINGS AND STANDARDS

A. Electrical Codes: All electrical work covered by the Contract Documents shall conform to the requirements of National Electrical Code, 2011 Edition, state and other local codes.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 FIXTURES

A. LED fixtures shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be well rounded and free from chips or rough edges.

B. These fixtures are intended as ones subject to abuse, and damp locations, and as such shall bear listing with the Underwriters' Laboratories as a damp-location fixture, enclosed and gasketed. Electrical feeds shall be through hubs at the end of the fixture.

1. Vandal-resistant construction shall consist of a 0.125 inch minimum uninterrupted thickness, color corrective, acrylic lens, retained by concealed stainless steel spring-loaded fasteners and interlocking extrusions. Entire mechanism shall be concealed within the extruded outer housing, such that the tamper resistant stainless hardware is flush with the outer wall of the luminaire.

C. All fixtures shall be complete with poles, hangers, supports, lamps, shielding, diffusers, insulation and all other accessories required for mounting and proper operation. All fixtures shall be UL labels. Check architectural drawings to verify ceiling types. Verify color of exposed trim and shielding medium with Engineer before ordering fixtures.

D. All fixture assemblies to be factory pre-wired to prescribed circuitry.

E. Lamp wattage shall be as indicated, and all fixtures shall be suitable for outdoor and vandal-resistant installation.

2.3 LAMPS

A. The Contractor shall furnish and install all fixtures as per lighting schedule and contract drawings.

2.4 LIGHTING POLES

Lighting poles shall be in accordance with the lighting schedule and contract drawings. Where poles are manufactured with an additional arm to support other than the lighting systems, they will be specified as follows:

Arm: Shall be made from aluminum tubing 6061 T6, 2 3/8" (60mm) outside diameter, welded.

Decorative Element: Bent decorative aluminum rod, 6063 T5 alloy, 1/2" (13mm) outside diameter, welded assembly.

Mounting Plate: (M), Made of cast 356 aluminum complete with a ground connection. For a 2" x 3" (51mm x 76mm) horizontal junction box.

Hardware: All exposed screws shall be stainless steel with Ceramic primer seal basecoat to reduce seizing of the parts. All seals and sealing devices are made and/or lined with EPDM and/or silicone and/or rubber.

Finish: Texture and color to be confirmed with the engineer. A polyester powder coat paint (4 mils/100 microns) with ± 1 mils/24 microns of tolerance shall be applied. The Thermosetting resins shall have discoloration resistant finish in accordance with the ASTM D 2244 standard, as well as luster retention in keeping with the ASTM D 523 standard and humidity proof in accordance with the ASTM D2247 standard.

The surface treatment shall achieve a minimum of 2000 hours for salt spray resistant finish in accordance with testing performed and per ASTM B117 standard.

Quality Control: The manufacturer must provide a written confirmation of its ISO 9001 2008 and ISO 14001 2004 International Quality Standards Certification.

2.5 POLE FIXTURES

Hood: A die cast A360.1 aluminum dome complete with a cast-in technical ring with latch and hinge. The mechanism shall offer tool free access to the inside of the luminaire. An embedded memory-retentive gasket shall ensure weatherproofing.

Housing: Round shape, housing made of cast 356 aluminum, c/w a watertight grommet, mechanically assembled to the bracket with four bolts 3/8-16 UNC. This suspension system permits for a full rotation of the luminaire in 90 degree increments.

Light Engine: LEDgine composed of 5 main components: Lens / LED lamp / Optical System / Heat Sink / Driver. Electrical components are RoHS compliant.

Lens: Made of soda-lime clear tempered glass lens, mechanically assembled and sealed onto the lower part of the heat sink.

Lamp: (Included) type Philips Lumileds Luxeon R. composed of 48 high-performance white LEDs, 80w lamp wattage (or 24 high-performance white LEDs, 40w).

Color temperature of 4000 Kelvin nominal, 70 CRI, operating lifespan based on TM21 extrapolation to get results after which 50% of LEDs still emits over 70% (L70) of its original lumen output. Use of metal core board insures greater heat

transfer and longer lifespan of the light engine. The LED circuit board is included with a connector, (no connection wire required for ease of replacement).

Optical System: (LE4F), IES type IV (asymmetrical). Composed of high-performance optical grade PMMA acrylic refractor lenses to achieve desired distribution optimized to get maximum spacing, target lumen and a perfect lighting uniformity. Optical system is rated IP66. Performance shall be tested per LM63 and LM79 and TM15 (IESNA) certifying its photometric performance. Street side indicated.Dark Sky compliant with 0% uplight and U0 per IESNA TM15.

Heat Sink: Made of die cast A360 aluminum optimizing the LEDs efficiency and life, complete with a cast in skirt and technical ring. Product does not use any cooling device with moving parts (only passive cooling device)

Driver: High power factor of 95%. Electronic driver, operating range 50/60 Hz. Auto-adjusting universal voltage input from 120 to 277 VAC rated for both application line to line or line to neutral, Class I, THD of 20% max. Maximum ambient operating temperature from -40F(-40C) to 130F(55C) degrees. Certified in compliance to UL1310 cULus requirement. Dry and damp location. Assembled on a unitized removable tray with Tyco quick disconnect plug resisting to 221F(105C) degrees.
The current supplying the LEDs will be reduced by the driver if the driver experiences internal overheating as a protection to the LEDs and the electrical components. Output is protected from short circuits, voltage overload and current overload. Automatic recovery after correction. Standard built-in driver surge protection of 2.5kV (min).

Surge Protector: LED Driver 3 poles 10KV surge Protectors that protect Line-Ground, Line-Neutral, and Neutral-Ground in accordance with IEEE / ANSI C62.41.2 guidelines.

2.6 ACCEPTABLE MANUFACTURERS

Manufacturers:

1. Philips LUMEC

Or

2. Approved equal.

2.7 LIGHTING CONTROL

A. Lighting control shall be as specified in 260923 - Lighting Control devices

2.8 EXIT SIGNS

A. Exit lighting units, with high impact housing and internal high output LEDs will be fed from the emergency panel via UPS..

PART 3 - EXECUTION

3.1 INSTALLATION

A. All lighting fixtures shall be installed in a neat and workmanlike manner and shall be mounted evenly and in line. Contractor shall determine the best location for fixtures and conduit runs. If, at any point, the construction will not permit the installation of the type of fixture shown on the Contract Drawings, the Contractor shall install a fixture of such type in such manner as directed by the Engineer. Where bracket fixtures are required, each fixture shall be adjusted to suit local conditions. Where pendant fixtures are required, approved suspension devices or rigid fittings shall be supplied and installed. Support pendant mounted fixtures with stems, 3/8" in diameter minimum, vertically attached to structural steel, concrete, beams, joists, and trusses. Contractor shall provide channel supports required to support the pendant fixtures. Wiring to pendant fixtures shall be run through the stem and iron bushing. All stem to box connections shall be secured with double nuts. All fixtures and hardware to be installed with Torx tamperproof screws. Stems for pendant fixtures shall be provided where necessary to make the height of all lamps uniform and in the same plane being dependent upon the minimum height of the ceiling in the areas indicated on the Contract Drawings. All steel and ceiling heights shall be verified in the field. All steel parts for the attachment of fixtures shall be hot-dip galvanized. Lead gaskets shall be provided between dissimilar metal mounting surfaces and metal to masonry interfaced.

B. The Contractor shall install, wire and illuminate five (5) fixtures for use as a test pattern to be approved. Upon approval, the Contractor shall complete the remaining light fixtures installation.

C. All fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors and lamps.

D. Lighting fixtures location is subject to coordination with other trades and final location will be determine by the contractor and approved by the Engineer.

E. The Contractor shall provide and install all inserts, conduit, structural supports as required, wiring, etc., and properly adjust and test, to the satisfaction of the Engineer, the entire lighting system.

F. The Contractor shall protect all fixtures at all times from damage, dirt, dust, etc. Before final acceptance, all fixtures and devices shall be cleaned of all dust, dirt or other material, be fully relamped and in operating condition to the satisfaction of the Engineer.

G. Circuiting shall be as shown on the Contract Drawings and as follows:

1. Bus loads in all panelboards shall be balanced between phases to within a tolerance of one (1) kVA. Convenience receptacles shall be distributed evenly among all phase buses as much as practicable.

2. Voltage drop to the most remote lighting fixture shall be limited to 3 percent.

H. The Contractor shall supply all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hangers permitting normal fixture motion and self-alignment. Pendant lengths shall be adequate and adjusted to provide uniformity of installation heights above the reference datum. Stems shall be one piece, with matching canopies and fittings.

I. The Contractor shall provide recessed fixtures with a separate junction box concealed and located as to be accessible when fixture is removed.

J. All lighting units, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.

K. The Contractor shall install fixtures at mounting heights indicated or as instructed by the Engineer. In areas with exposed ducts and/or piping, installation of lighting fixtures shall be adapted to field conditions as determined by the Engineer.

L. The Contractor shall support each fixture securely. The Contractor shall not secure fixtures to the work of other trades, unless specified or noted otherwise, and shall not support fixtures to plaster. The Contractor shall furnish and install all steel members and supports as required to fasten and suspend fixtures from the structure.

M. In all mechanical equipment areas, the Contractor shall install lighting fixtures on ceiling after all piping and equipment therein have been installed. Exact locations for such fixtures may be determined by the Engineer on the site during the course of the work.

N. Upon completion of work, and after the area is broom clean, all fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors, and lamps.

O. All fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of fixtures and/or lamps, as directed.

P. Re-lamping access shall require no special tools. All optical control surfaces such as lenses and reflectors shall be safely and securely attached to fixtures and shall be easily and quickly removed and replaced for cleaning without the use of tools. No fixture part that may be removed, for maintenance, shall be held in place by metal tabs that must be bent to remove said part.

Q. The Contractor shall install switches 4 ft. above the floor at the locations shown, and shall be single pole or double pole, as indicated.

R. All switches shall be enclosed in cast boxes and shall be furnished with waterproof, cast covers having external operating arms equal to Russell and Stoll; Appleton Electric or equal, for surface mounting. The Contractor shall provide all covers with rubber or neoprene gaskets.

S. Evenly proportion all fixtures in the room except where adjusted to conform with ceiling pattern as described below and where otherwise shown on drawings. Edges of the fixture shall be parallel with the walls.

T. All fixtures must hang true to vertical, free from finger marks, flaws, scratches, dents or other imperfections. Take care when hanging fixtures not to deface in any way, ceiling or walls.

U. Install continuous rows of fixtures in a straight line and at the same level. Fixtures must not be rotated about longitudinal axis with respect to one another. Mount surface fixtures tight to surface without distorting it. Provide proper mounting equipment for recessed fixtures to adapt them to the ceiling or wall construction and to prevent light leaks around trim. All stem mounted fixtures shall be hung level from self-aligning hangers in canopies.

V. Securely support all ceiling fixtures, hangers, and outlet boxes from structural members, not ceiling members. Plastic inserts are not permitted. Supports for each fixture shall be capable of supporting four times fixture weight.

W. At acceptance of the work, the Contractor shall clean all fixtures and install new lamps. Contractor shall supply 10 percent spare lamps for all fixtures. Spare lamps shall be stored in the original manufacturer supply carton.

X. Cables shall be installed in accordance with the requirements of NFPA 70. If paving or Railroad track is already in place wrought-iron or galvanized steel pipes shall be driven under it. Where rigid steel conduit installed underground without concrete encasement is indicated, the conduit shall have a factory-applied coating with minimum thickness not less than the following:

1.	Low-density or medium-density plastic	0.040-inch
2.	Epoxy resin	0.08-inch
3.	Coal-tar enamel	0.63-inch

3.2 FIELD TESTS AND INSPECTIONS

A. Perform all field tests and provide all labor, equipment, and incidentals required for testing, except when the client will provide electric power required for field tests when available.

B. After installation has been completed, the Contractor shall conduct an operating test. The equipment shall be demonstrated to operate in accordance with the requirements of this Section.

C. Show by demonstration in service that circuits, fixtures, and equipment are in good operating condition. Tests shall be such that each piece of control equipment shall function not less than 5 times. The Contractor shall give the Engineer 5 days advance notice of the dates and times for tests and inspections.

D. Interior installations shall be tested for insulation resistance after all wiring is completed and connected, ready for the attachment of fixtures and equipment, and again when fixtures and equipment are connected, ready for use. Test shall be as specified in Section 260800. All defective material and workmanship disclosed as the result of the tests given herein shall be corrected at no cost to the client. Demonstrate in service that all circuits and devices are in good operating condition.

E. Deficiencies shall be rectified and work affected by such deficiencies shall be completely retested at the Contractor's expense.

END OF SECTION 265600

SECTION 265626 – SITE LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

1.2 SUMMARY

A. Section includes:
1. Exterior luminaries with lamps and ballasts;
2. Poles and accessories;
3. Luminaire lowering devices.

1.3 DEFINITIONS:

A. CCT: Correlated color temperature

B. CRI: Color-rendering index

C. LED: Light-emitting diode

D. LER: Luminaire efficacy rating

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

F. Pole: Luminaire support structure

D. Standard: Same definition as “pole” above

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION:

A. Dead Load: Weight of luminaire and its horizontal and vertical supports and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Ice Load: Load of 3 lbf/sq. ft.. applied as stated in AASHTO LTS-4-M

C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed for calculating wind load for poles exceeding 49.2 feet in height is 120 mph.
   a. Wind Importance Factor: 1.0.
   b. Minimum Design Life: 50 years.
   c. Velocity Conversion Factors: 1.0.
2. Basic wind speed for calculating wind load for poles 50 feet high or less is 120 mph.
   a. Wind Importance Factor: 1.0
   b. Minimum Design Life: 25 years.
   c. Velocity Conversion Factors: 1.0.

1.5 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR-SUBMITTALS.

B. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Details of attaching luminaires and accessories.

3. Details of installation and construction.

4. Luminaire materials.

5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.

6. Ballasts, including energy-efficiency data.

7. Lamps, including life, output, CCT, CRI, lumens and energy-efficient data.

8. Materials, dimensions, and finishes of poles.

9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

10. Anchor bolts for poles.

11. Manufactured pole foundations.

C. Shop drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Pole and support component certificates.

E. Maintenance Data: Include operation and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR-CLOSEOUT DOCUMENTS.

F. Warranties: Special warranties specified in Part 1.8, “warranty.”

1.6 QUALITY ASSURANCE:

A. Source Limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Luminaire photometric data testing laboratory qualifications.

C. Electrical components, devices and accessories.

D. Comply with IEEE C2, “National Electrical Safety Code.”

E. Comply with NFPA 70.

F. Source limitations: Obtain from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.7 DELIVERY, STORAGE AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Package aluminum poles for shipping according to ASTM B660.

C. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

D. Retain factory-applied pole wrappings on metal poles until right before pole installation.

For poles with nonmetallic finishes, handle with web fabric straps.

E. Refer to Form 816 Article 1.06.03 and Form 816 article 1.20-1.06.03 for additional information.

1.8 WARRANTY:

A. Refer to Form 816 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR-CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repaired repairs or alterations from special warranty coverage.
1. Warranty period for luminaires: Five years from the date of substantial completion.
2. Warranty period for metal corrosion: Five years from the date of substantial Completion.
3. Warranty period for color retention: Five years from date of substantial completion.
4. Warranty period for poles: repair or replace lighting poles and standards that fail in finish, materials and workmanship within manufacturer's standard warranty period, but not less than three years from the date of substantial completion.

1.9 SPARE PARTS:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified labels.
1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass and plastic lenses, covers and other optical parts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Ballast: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

1.10 COORDINATION

A. Furnish bolt templates and pole mounting accessories to installer of pole foundations.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, products indicated on drawings.

2.2 LUMINARIES

A. Luminaires shall comply with UL 1598 and be listed labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
1. LER tests HID fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral light distribution patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal parts: Free of burrs and sharp corners and edges.

D. Sheet metal components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather-and light –tight enclosures that will not wrap, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, frames, and other internal access: smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed hardware material: Stainless steel.

H. Plastic parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light shields: Metal baffles, factory installed and filed adjustable, arranged to block light distribution to indicated of normal illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White surface: 85 percent
2. Specular surfaces:83 percent
3. Diffusing specular surfaces:75 percent

K. Lenses and refractors gaskets: Use heat and aging resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire finish: manufacturer's standard paint applied to factory-assembled and tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

M. Factory-applied finish for steel luminaires: comply with NAAMM's "Metal finishes manual for Architectural and metal products" for recommendations for applying and designating finishes.

N. Factory-applied finish for aluminum luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

O. Factory-applied labels: Comply with UL1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.3 LED FIXTURES

A. The complete system shall be capable of starting and operating the light engine within the limits specified by the LED manufacturer. The luminaire shall contain completely prewired integral drivers and an optical assembly that shall provide a distribution type, specified according to the drawings.

B. Labeling shall be in accordance with ANSI standards. All units shall be UL Certified.
C. Light Engine: Composed of 4 main components:

1. LED lamp
2. Optical System
3. Heat Sink
4. Driver

D. Electrical components shall be RoHS compliant.

E. Lens: Made of soda lime tempered glass lens, mechanically assembled and sealed onto the lower part of the heat sink.

F. Lamp: (Included), Composed of high performance white LEDs. Color temperature of 3500 Kelvin nominal, 70 CRI. Operating lifespan, 70 000 hours after which the system emits 70% of its original lumen output, all of those parameters are tested for 100% of light engines. Provide metal core board to insure greater heat transfer and longer lifespan of the light engine

G. Optical System: Composed of high performance collimators, optimized with varying acrylic beam angles to achieve desired distribution. System is rated IP66. Performance shall be tested per LM63 and LM79 (IESNA) certifying its photometric performance.

H. Heat Sink: Made of cast aluminum optimizing the LEDs efficiency and life. Product shall not use any cooling device with moving parts (passive cooling device)

I. Driver: High power factor of 90%. Electronic driver, 60 Hz. Auto adjusting to a voltage between 120 and 277 volt AC, Class II, THD of 20% max. Maximum ambient operating temperature from 40F to 130F degrees. Certified in compliance to CUL requirement Weather tightness rating IP66. Assembled on a unitized removable tray with Tyco quick disconnect plug resisting to 221F degrees

J. The current supplying the LEDs shall be reduced by the driver if the internal temperature exceeds 185F, as a protection to the LEDs and the electrical components. Output is protected from short circuits, voltage overload and current overload. Automatic recovery after correction.

K. Surge Protector: LED Driver 3 poles surge Protectors that protect Line Ground, Line Neutral, and Neutral Ground in accordance with IEEE / ANSI C62.41.2 guidelines.

2.4 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural characteristics; Comply with AASHTO LTS-4-M.

1. Wind-Load strength of poles: Adequate at indicated height above grade without failure permanent deflection, or whipping in steady winds of 100mph with a gust of 1.3.
2. Strength analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire attachment provisions: comply with luminaire manufacturer' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, fasteners, and appurtenances: corrosion-resistant items compatible with support components.

D. Power installed screw foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

E. COORDINATE COLOR AND FINISH WITH THE ARCHITECT.

2.6 STEEL POLES:

A. Poles: ASTM A572, Galvanized Steel with access handhole in pole wall.

1. Shape: Round, tapered/Round, straight
2. Mounting provisions: Butt flange for bolted mounting on foundation or breakaway support.

C. Pole-top tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and bonding lugs: welded ½-inch threaded lug, complying with requirements in Division 26 section “Grounding and Bonding for electrical Systems, “ listed for attaching grounding and bonding conductors of type and size listed in that section, and accessible through handhole.

E. Brackets for luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.
   1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
   2. Finish: Same as luminaire.

F. Prime-coat finish: manufacturer’s standard prime-coat finish ready for field painting.

G. Steel finish: Comply with NAAMM’s “Metal Finishes Manual for Architectural and Metal Products” for recommendations for applying and designating finishes.

PART 3 EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.2 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and Project conditions.

B. Verify foundations are ready to receive fixtures.

3.3 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimim directional alignment of luminaires and their mounting provisions on the pole.

B. Foundation-mounted poles: mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

C. Poles and pole foundations set in concrete paved areas: install poles with minimum of 6-inch wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab.

3.4 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

A. Install on concrete base per the contract drawings. Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer..

B. Cast conduit into base and finish by troweling and rubbing smooth. Concrete materials, installation and finish are in Division 03.

3.5 CORROSION PREVENSION

A. Aluminum: Do not use in contact with earth concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel conduits: Comply with Div 26 section “raceway and boxes for Electrical systems. “ In concrete foundations, wrap conduit with 0.010-inch thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 GROUNDING:

A. Ground metal poles and support structures according to Div 26 section “Grounding and bonding for electrical systems”

3.7 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination observations: verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

C. Illumination tests:
1. Measure light intensitiesat night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guides:
    a. IESNA LM-64, “Photometric Measurements of Parking Areas”

    b. IESNA LM-50, “Photometric Measurements of Roadway Lighting Installations”

    c. IESNA LM-72, “Directional Positioning of Photometric Data”

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

E. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

F. Take measurements during night sky, without moon or with heavy overcast clouds

effectively obscuring moon.

3.8 ADJUSTING

A. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings.

3.9 CLEANING

A. Clean photometric control surfaces as recommended by manufacturer.

B. Clean finishes and touch up damage.

3.10 PROTECTION OF FINISHED WORK

A. Protect surfaces from contact with contaminating substances and from damage resulting from construction operations or other causes so surfaces are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated components immediately and replace.

END OF SECTION

SECTION 266000 – ELECTRICAL VEHICLE CHARGING STATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. Electric Vehicle Supply Equipment (EVSE)

1.02 REFERENCE

The equipment and components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted).

A. SAE J1772 Standard for Electric Vehicle Conductive Charge Coupler.

B. NFPA 70 National Electrical Code

C. UL 2202, Electric Vehicle (EV) Charging System Equipment

D. UL 2231, Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits

E. UL 2251, Plugs, Receptacles and Couplers for Electric Vehicles

F. UL 2594, Electric Vehicle Supply Equipment

G. UL and cUL listed

H. ISO 15693

1.03 SYSTEM DESCRIPTION

A. Level 2 charging or IEC 6219 Mode 3

B. 208-240 volt, single phase, 30A, 7.2kW, 60 Hz power system equipped with earth ground supplied by a dedicated 2-pole 40A 80% rated breaker.

C. Nuisance tripping avoidance and auto re-closing

D. Wiring shall be determined from NEC 310.16 table adhering to all correction factors.

E. Network communication protocol TCP/IP

F. LED light with multiple colors displaying charging status

G. Vacuum Fluorescent Display (VFD) screen showing EVSE communications including single phase metering

H. Radio Frequency identification (RFID) option to control user authorization for EVSE

I. RFID supporting software application

J. Supplemental power supplied by photovoltaic (PV) system provided as part of EVSE system – REQUIREMENTS TO BE CONFIRMED.

1.04 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Manufacturer shall provide [3] copies of the following documents to owner for review and evaluation in accordance with general requirements of Division 26:

1. Product Data on specified product

2. Shop Drawings on specified product

1.05 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.06 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

1.07 INSTALLATION, OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide [3] copies of installation, operation and maintenance procedures to owner in accordance with general requirements of Division 26.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

B. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.

C. Contractor shall inspect and report concealed damage to carrier within 48 hours.

D. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.

E. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish.

F. Follow (standards) service conditions before, during and after EVSE installation.

1.09 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information

B. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

1.10 FIELD MEASUREMENTS

A. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

PART 2 PRODUCTS

2.01 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.02 MANUFACTURER

A. General Electric Company products have been used as the basis for design. Other manufacturers' products of equivalent quality, dimensions and operating features may be acceptable, at the Engineer's discretion, if they comply with all requirements specified or indicated in these Contract documents.

2.03 EQUIPMENT

A. Furnish GE EV Charging Station or approved equal

1. Level 2 charging

2. NEMA 3R enclosure for wall, pole, single and double pedestal mounting options

2.04 COMPONENTS

A. 20’ connected charging cord

B. RFID Module (optional)

C. Ethernet to support RFID communication

D. LED charging status display

E. VFD screen displays greeting, instructions and message

F. Integrated ground fault protection (20mA CCID)

G. Vehicle ground monitor interrupter

H. Single phase integrated meter

I. Pole mounting brackets (for Wall mount units only)

2.04 FINISH

A. Hot-rolled, Low Carbon Steel with powder coat finish

2.05 TESTING

A. In accordance with manufacturer literature

PART 3 EXECUTION

3.01 EXAMINATION

A. The following procedures shall be performed by the Contractor.
   1. Examine installation area to assure there is enough clearance to install EVSE.
   2. Check concrete pads for uniformity and level surface.
   3. Verify that equipment is ready to install.
   4. Verify field measurements are as instructed by manufacturer.
   5. Verify that required utilities are available, in proper location and ready for use.
   6. Beginning of installation means installer accepts conditions.
   7. Verify proper IT infrastructure provisions are installed

3.02 INSTALLATION

A. Installation shall be performed by the Contractor.

A. Install per manufacturer's instructions.

B. Install additional safety labels if needed per district

END OF SECTION 266000

SECTION 273226 - BLUE LIGHT / EMERGENCY TELEPHONE (BL/ETEL) SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. This Section specifies the minimum requirements for Blue Light/Emergency Telephone (BL/ETEL) System. This section includes Furnishing, installing, and testing new phones, cabling and connection to, miscellaneous equipment required for connectivity. Work shall include all necessary coordination to assure all BL/ETEL components, cabling and infrastructure are provided and installed (in conjunction with equipment provided by others) to provide a complete aesthetic and functional BL/ETEL system.

D. The System shall be integrated with the Video Surveillance Systems as necessary to allow automatic camera call-up upon activation.

E. Communication between blue light stations and Operations/Emergency Response Personnel shall be by the use of the blue light station per NFPA 130 and a PBX phone circuits.

1.2 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: All equipment shall conform to the requirements of the Amtrak Police Department Corporate Security – Guidance, Practices and Recommendations 2011 rev 3.

C. Shop Drawings: Include block diagrams, detail mounting locations, and rack layouts.

D. Product Samples: The Designer will not make a color selection until it can be coordinated with other Division 9 color selections.

1.3 CLOSEOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE:

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01

B. Conduct a Pre-Installation Meeting at the Project Site in compliance with the requirements of Form 816 Article 1.20-1.05.24 subsection 2.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.6 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 BLUE LIGHT/EMERGENCY TELEPHONE (BL/ETEL) SYSTEM

A. Low-voltage power, signal and data cabling is provided under Division 26. Coordinate all cabling size requirements to assure compatibility with equipment and installed by others.

2.3 EMERGENCY TELEPHONE (ETEL) UNIT:

A. Coordinate with the Architect regarding equipment dimensions. Mounting requirements/locations, and cabling size requirements to assure that the BL/ETEL System infrastructure provided is compatible with the ETEL Unit.

B. Activation of a BL/ETEL station by lifting the ETEL handset from its on-hook position shall initiate communication to the Amtrak Police Department

2.4 BLUE LIGHT (BL) UNIT

A. Blue Light (BL) Unit to be provided and as an integral part of the BL/ETEL System.

B. The BL Unit shall be constantly illuminated and be located directly above the ETEL Unit per NFPA 130.

2.5 LOOP DETECTOR BOARD (LDB) UNIT

A. Loop Detector Board Unit to be mounted within the ETEL Unit housing.

B. The LDB shall interface the ETEL Unit with the VSS camera call-up. Lifting the ETEL handset from its “on-hook” position shall cause the LDB to initiate a dry relay contact signaling an alarm and call-up the designated security camera.

C. When the ETEL Unit is activated, the LDB’s output contact will trigger an alarm and activate automatic call-up action on the VSS.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL:

A. Inspect all Blue Light/Emergency Telephone Station (BL/ETEL) System equipment for quality of installation and verify system performance in accordance with manufactures instructions.

3.2 TRAINING:

A. Refer to Form 816 Article 1.20-1.08.14 subsection 3 for additional information.

END OF SECTION 273226

SECTION 274216 - PASSENGER INFORMATION DISPLAY (PID) SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled “SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY” and other Amtrak Specifications contained in the Contract.

C. The Work specified in this Section consists of furnishing and installing communication conduit and cables, power conduit and cables, and LED matrix displays for the Passenger Information Display (PID) system as indicated.

1.2 RELATED DOCUMENTS

A. Drawings and Contract Terms and Conditions

B. Amtrak Graphic Standard Signage Manual and Station Guidelines

C. Requirements of the following Division 26 Sections apply to this Section:

1. Common Work Results for Electrical - Section 260500.
2. Low Voltage Electrical Power Conductors and Cables - Section 260519.
3. Hangers and Support for Electrical Systems - Section 260529.

1.3 SUMMARY:

A. This Section includes requirements for the Passenger Information Display systems.

B. The Contractor shall furnish and install all LED matrix displays, cable and conduit associated with the PID systems including the PA/PID system head-end equipment enclosure within the Telecom Room and make final terminations to this equipment.

1.4 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product data for each type of product specified.

C. Maintenance data for materials and products, for inclusion in Operating and Maintenance Manual. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.

1.5 CLOSEOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALITY ASSURANCE:

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code".

1.7 DELIVERY, STORAGE AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 – PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 PASSENGER INFORMATION DISPLAY (PID):

A. PID system LED matrix displays and visual messaging monitors shall be:

1. Single Face: Daktronics Galaxy Model AF-6121-32x144-8-A-SF.
2. Double Face: Daktronics Galaxy Model AF-6121-32x144-8-A-DF

3. Single sided 46” LCD flat screen monitor, wall or ceiling mounted

B. PID cable shall consist of two 4 pair #23AWG solid copper conductors bonded in pairs within an overall foil shield. Belden # 7953A Cat 6/RS-422 cable or equal

C. The PA/PID Head end equipment shall be include all patch panels, network switches, Video transmitters and Audio amplifiers, necessary to provide a CT DOT/ Amtrak compliant working system.

PART 3 – EXECUTION

3.1 EXAMINATION:

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the system work.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install system in accordance with NFPA 70 and other applicable codes.

B. In accordance with Section 260533 "Raceways and Boxes for Electrical Systems."

3.3 TESTING:

A. Perform all PA and PID system field tests and provide all labor, equipment, and incidentals required for testing.

B. After installation has been completed, the Contractor shall conduct an operating test of the PA/PID system to demonstrate it operates in accordance with the requirements of this Section.

C. The Contractor shall show by demonstration in service that circuits and field devices are in good operating condition. The Contractor shall give the Engineer 5 days advance notice of the dates and times for tests and inspections.

D. All defective material and workmanship disclosed as the result of the tests given herein shall be corrected at no cost to the owner.

3.4 CLEANING AND PROTECTION:

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 274216

SECTION 275116 – PUBLIC ADDRESS SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. The Work specified in this Section consists of furnishing and installing communication conduit, cables and speakers for the Public Address (PA) system as shown on drawings.

1.2 RELATED DOCUMENTS

A. Drawings and Contract Terms and Conditions

B. Amtrak Graphic Standard Signage Manual and Station Guidelines

C. Requirements of the following Division 26 Sections apply to this Section:

1. Common Work Results for Electrical - Section 260500.
2. Low Voltage Electrical Power Conductors and Cables - Section 260519.
3. Hangers and Support for Electrical Systems - Section 260529.

1.3 SUMMARY:

A. This Section includes Amtrak requirements for the Public Address systems.

B. The Contractor shall furnish and install all speakers, cable and conduit associated with the PA systems including the PA/PID system head-end equipment enclosure within the Telecom Room and make final terminations to this equipment.

1.4 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product data for each type of product specified.

C. Maintenance data for materials and products, for inclusion in Operating and Maintenance Manual. Provide complete manual material concurrently with system submittal and provide updated final versions of manuals one month before completion of construction and final system turnover.

1.5 CLOSEOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALITY ASSURANCE:

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 "National Electrical Code".

1.7 DELIVERY, STORAGE AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.8 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 – PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information.

2.2 PUBLIC ADDRESS SYSTEMS:

A. PA system speakers shall be grey baked epoxy double re-entrant type with compression driver mounted within a Flange weather-resistant housing. Audio power capability shall be 15 Watts continuous. Transformer-equipped loudspeaker shall have impedance selection position switch. Power taps shall be available on 70.7V line. Loudspeaker mounting shall be as shown on drawings.

1. Interior: Atlas Sound Model APF-15T with Model L20-100 grille.
2. Exterior: Atlas Sound Model APF-15T installed in Model VP410-S vandal-proof enclosure with FAMT-6 adapter plate.

B. 1. Speaker wire shall be two #18 awg high conductivity copper conductors such as Belden # 8460 or equal.

C. 1. Multi-channel, amplified monitor panel shall be Atlas Sound Model MVXA-2008 or MVXA-2016 or approved equal. Unit shall be capable of visually monitoring 8 or 16 channels simultaneously. Independent aural monitoring of each channel shall be provided by an internal speaker, a headphone jack, a 3-watt speaker level output, and a line level output to drive an external amplifier. It shall be able to monitor any combination of line level, inputs. It shall feature standard E.I.A.

PART 3 – EXECUTION

3.1 EXAMINATION:

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the system work.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

A. General: Install system in accordance with NFPA 70 and other applicable codes.

B. In accordance with Section 260533 "Raceways and Boxes for Electrical Systems."

3.3 TESTING:

A. Perform all PA system field tests and provide all labor, equipment, and incidentals required for testing the PA/PID equipment.

B. After installation has been completed the Contractor shall demonstrated the PA and PID systems operate in accordance with the requirements of this

C. The Contractor shall show by demonstration in service that circuits and field devices are in good operating condition. The Contractor shall give the Engineer 5 days advance notice of the dates and times for tests and inspections.

D. All defective material and workmanship disclosed as the result of the tests given herein shall be corrected at no cost to the owner.

3.4 CLEANING AND PROTECTION:

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 275116

SECTION 282301 - VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. The Work specified in this Section consists of furnishing and installing communication conduit and cables, power conduit and cables, and cameras for the Video Surveillance System (VSS) as indicated.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the Amtrak Police Department Corporate Security – Guidance, Practices and Recommendations 2011 rev 3 and specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

1.3 SUMMARY

A. Section includes a stand alone, onsite video surveillance recording system consisting of IP Megapixel digital cameras, digital network video recorder, data transmission wiring, and a control station with its associated equipment.

1.4 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. FO: Fiber Optic.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. WAN: Wide area network.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.6 ACTION SUBMITTALS

A. A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.

3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.

4. UPS: Load requirements for sizing calculations.

5. Wiring Diagrams: For power, signal, and control wiring.

6. Room HVAC requirements.

D. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.7 INFORMATIONAL SUBMITTALS

A. A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Seismic Qualification Certificates: For video surveillance, cameras, camera-supporting equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

B. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to emergency, operation, and maintenance manuals include the following:

1. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.9 QUALITY ASSURANCE

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NECA 1.

D. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F, dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Refer to drawings for enclosure type and requirements.

2. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.11 DELIVERY, STORAGE AND HANDLING

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.12 WARRANTY

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information

2.2 SYSTEM REQUIREMENTS

A. Video-signal format shall comply with NTSC standard, composite interlaced video.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."

2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Section 264313 "Transient-

Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.3 CAMERAS

A. Cameras for Platforms, Stair towers, Pedestrian Bridge, and Lobby areas shall be fixed dome HD network type cameras as manufactured by Pelco, or equal in accordance with the following:

1. Fixed color/day-night high definition digital megaplex IP network camera.

2. Externally powered by 120 volt AC.

3. Lens: Vari-focal 2.8 – 12mm (F1.2 to 2.1) IR Corrected, Auto Iris, and 4x zoom ratio.

4. Resolution: 3 Megapixel (2048 x 1536) in color and day/night.

5. Sensitivity: 0.03 lux at F1.4 and Day/Night IR sensitive.

6. Two Simultaneous video streams of 720p High Definition H.264 and M-JPEG at 30fps.

7. Cabling: Multi-Mode Fiber optic cable .

8. Vandal resistant and weatherproof heated enclosure (Pelco Mini Dome or Equal).

B. Cameras for end of track viewing shall be outdoor IP network fixed infa-red long distance camera by Pelco or equal in accordance with the following:

1. 1/3" CCD Image Sensor

2. Lens: 3-90mm Varifocal lens with 12x electronic zoom auto focus and Iris

3. Resolution: 500 lines (Day) 700 lines (Night).

4. Sensitivity: 0.02 lux .

5. IR LED Illuminators capable of 300 ft. range and 40° angle.

6. Intelligent Video Analysis (IVA) enabling the camera to be programmed to detect loitering, line crossing and other potential threats

7. Vandal resistant and weatherproof heated enclosure

C. Cameras shall be rigidly mounted with stainless steel fasteners. Wiring shall be in armored flexible cable to local junction box (within 3'). Provide rigid steel conduit mounted to underside of canopy back to head-end equipment.

D. The cameras shall be connected by Fiber optic cable having the following features:

1. 62.5/125um Multi-Mode fibers with sufficient spares.

2. Flame retardant polyvinyl chloride (PVC) insulation and jacket.

3. Flexible buffer tube assembly.

4. Each fiber optic cable shall be identified by means of surface ink printing indicating manufacturer, type and quantity.

2.4 EQUIPMENT RACK

A. Provide a free standing rack to house surge suppressor, Media Converter, Network switch NVR Server/DVD burner, power supply, fold out keyboard and 17"LCD monitor.

B. Rack shall be a steel free standing enclosure 70"high, 40" deep, 24"wide, nominal and include 40 rack units.

C. Provide service light, vertical power strip (entire height of rack), and cable management ladder.

D. Provide cooling fans and temperature monitor with a thermostat.

2.5 NETWORK SWITCH

A. Cisco 2960 Series or equal.

B. Product Description:

1. Up to 48 10/100/1000 ports plus four Small Form-Factor Pluggable plus (SFP+) providing fast transition to 10 Gigabit Ethernet.

2. Ethernet Connections: 24 ports or 48 ports RJ-45 10/100/1000Mbps Autosensing

3. Uplink Ports using SFP's: Accepts Single Mode, multimode and Copper SFPs

4. Ring Break and Power Loss Signals: Ring Break Alarm Relay: relay closed when configured as ring, Power Loss Relay: relay closed when power on.

5. Power Over Ethernet on 24 or 48 Service Ports: 15.4 Watts max per port. Dual zone power – separate power supply for each group of 24 Ethernet ports

2.6 NETWORK VIDEO RECORDER WITH DVD BURNER

A. Pelco Digital Sentry or equal

B. Network Video Recorder (NRV) shall have :

1. Latest generation processor with 8 GB of RAM and a fully Open Architecture.

2. HD video recording for up to 128 combined IP and analog cameras.

3. Available throughput of 280 Mbps

4. Up to 12TB of storage with a optical disk drive.

2.7 UNINTERRUPTIBLE POWER SUPPLY (UPS):

A. An external UPS circuit shall be provided sized to provide 90 minutes operation of the security system under normal operating conditions (recording).

B. Provide all load information for UPS sizing calculations, including each piece of security equipment, to support same equipment for 90 minutes.

2.8 RACK MOUNTED POWER SUPPLIES

A. Provide two rack mounted power supplies Pelco RCS series or equal to power the cameras. Power supply shall have the following features:

1. 26 volt output AC.

2. Main LED indicator

3. Self resetting circuit breakers.

4. Removable terminal strips with clamp down connectors.

2.9 NETWORK VIDEO RECORDERS: Pelco or Equal

A. Internal storage: 12 Terabyte hard disk drive.

1. Video and audio recording over TCP/IP network.

2. Video recording of H.264, MJPEG, and MPEG-4 IP Streams.

3. Video recording up to 280 Mbps available throughput.

4. Duplex Operation: Simultaneous recording and playback.

5. Continuous and alarm-based recording.

6. Full-Featured Search Capabilities: Search based on camera, time, or date.

7. Automatic data replenishment to ensure recording even if network is down.

8. Digital certification by watermarking.

9. Internal RAID storage or non-RAID storage of up to 1500 GB.

10. Capable of adding external RAID storage up to 24 TB.

11. Full integration with LAN, Intranet, or Internet through standard Web browser or video management software.

12. Integrated Web server FTP server functionality.

2.10 REMOTE VSS ENCLOSURES

A. NEMA 4 vandal resistant, freestanding enclosure shall be supplied for parking lot cameras. It shall include incoming power circuit breaker and or fusing for the following components:

1. Ethernet Switch for up to 48 (POE) connected cameras

2. Media Converter for communication back to head end equipment within the Telecom room.

3. UPS power supply

4. Cabinet heater and ventilation fan

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

B. Wiring Method: Install cables in RGS conduit unless otherwise indicated.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 84-inch minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

E. Avoid ground loops by making ground connections only at the control station.

1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.

F. Identify system components, wiring, cabling, and terminals according to Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

a. Prepare equipment list described in "Informational Submittals" Article.
b. Verify operation of auto-iris lenses.
c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.

e. Set and name all preset positions; consult Owner's personnel.
f. Set sensitivity of motion detection.
g. Connect and verify responses to alarms.
h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

D. Video surveillance system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.

2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.

3. Adjust all preset positions; consult Owner's personnel.

4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.

5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 282301

SECTION 283101 – FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY:

A. Drawings and general provisions of the Contract, including General Conditions of Division 1, State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, and Incidental Construction, Form 816 - 2004 and supplemental specifications thereto, shall be a part of this specification.

B. Work included in this section may require coordination with Amtrak regarding track outages, flagmen, or other issues related to work around railroad facilities. The Contractor shall pay special attention to the specification entitled "SAFETY AND PROTECTION OF RAILROAD TRAFFIC AND PROPERTY" and other Amtrak Specifications contained in the Contract.

C. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

D. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

E. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:

1. Fire alarm and detection operations.
2. Control and monitoring of elevators, fire suppression systems, emergency power systems, and other equipment as indicated in the documents.
3. One-way supervised automatic voice alarm operations.
4. Manual public address

1.2 ACCEPTABLE MANUFACTURERS:

A. Manufacturers:

1. Subject to compliance with specification requirements, suitable products by one of the following manufacturers will be considered by Engineer:
   a. Simplex Grinnell or approved equal

B. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.

C. The Manufacturer, or its approved representative shall employ factory trained and NICET certified technicians, and shall maintain a service organization within 30 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the fire protective signaling systems industry.

1.3 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:

1. Division 26: "Basic Electrical Materials and Methods."

C. The system and all associated operations shall be in accordance with the following:

1. Guidelines of the following Building Code: Building Code of the State of Connecticut
2. NFPA 72, National Fire Alarm Code
3. NFPA 70, National Electrical Code
4. NFPA 70E, Electrical Safety Requirements for Employee Workplaces
5. NFPA 101, Life Safety Code
6. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
7. FM Global approved Fire Alarm Control Panel as well as all associated signal and notification devices.
8. Local Jurisdictional Adopted Codes and Standards
9. ADA Accessibility Guidelines

1.4 SYSTEM DESCRIPTION:

A. General: Provide a complete, non-coded, addressable microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

B. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one

active and one in reserve. Panel shall be capable of full system operation during a new configuration download. The fire alarm manufacturer shall provide all software.

C. History Logs: The system shall provide a means to recall incoming alarms and trouble conditions, as well as a history of when alarms have been cleared in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

D. Wiring/Signal Transmission:

1. Transmission shall be hard-wired, using addressable signal transmission, dedicated to fire alarm service only.

2. System connections for initiating circuits and notification appliance circuits shall be Class B.

3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

E. Required Functions: The following are required system functions and operating features:

1. Priority of Signals: Alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.

2. Non-interfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent activations.

3. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator.

4. General Alarm: A system general alarm shall include:
   a. Identification of the device or zone that is the source of the alarm at the FACP.
   b. Operation of audible and visible notification devices throughout the building until silenced at FACP.

c. Shutting down supply and return fans serving zone where alarm is initiated.
d. Initiation of smoke control sequence through the existing building management control system shall not be affected by the fire alarm panel control functions.
e. Notifying the local 911 service using a dial-up modem
f. Initiation of elevator recall in accordance with ASME/ANSI A17.1, when specified detectors or sensors are activated.

5. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation.

6. System Reset
   a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarming the system. The display message shall indicate, "ALARM PRESENT, SYSTEM RESET ABORTED."
   b. Should an alarm condition continue, the system will remain in an alarmed state.

7. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.

8. WALKTEST: The system shall have the capacity of 8 programmable passcode protected one-person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
   a. The city circuit connection and suppression release circuits shall be bypassed for the testing group.
   b. Control relay functions associated to one of the 8 testing groups shall be bypassed.
   c. The control unit shall indicate a trouble condition.
   d. The alarm activation of any initiation device in the testing group shall cause the audible notification appliances to sound a voice announcement to identify the device or zone.
   e. The unit shall automatically reset itself after signaling is complete.
   f. Any momentary opening of an initiating or notification appliance circuit wiring shall cause the audible signals to voice announce the trouble condition.

F. Analog Smoke Sensors:

1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.

2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.

3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.

4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.

5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to indicate that a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate that a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a dirty sensor without creating a trouble in the system. If this indicator is ignored, a second level "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported [to the Central Monitoring Station]. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.

   a. The FACP shall continuously perform an automatic self-test on each sensor, which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.

6. Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity.

7. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.

8. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.

G. Audible Alarm Notification: By voice evacuation and tone signals on loudspeakers in areas as indicated on drawings.

1. Automatic Voice Evacuation Sequence:

a. The audio alarm signal shall consist of an alarm tone for a maximum of five seconds followed by an automatic digital voice message. At the end of the voice message, the alarm tone shall resume. This sequence shall sound continuously until the "Alarm Silence" switch is activated.
b. All audio operations shall be activated by the system software so that any required future changes can be facilitated by authorized personnel without any component rewiring or hardware additions.

H. Speaker: Speaker notification appliances shall be listed to UL 1480.

1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.

2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.

3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.

I. Manual Voice Paging

1. The system shall be configured to allow voice paging. Upon activation of any speaker manual control switch, the alarm tone shall be sounded over all speakers in that group.

2. The control panel operator shall be able to make announcements via the push-to-talk paging microphone over the pre-selected Switch/LED modules to accommodate the following zoned paging:

a. All Call
b. 1st floor
c. 2nd floor

3. The pre-recorded voice messaging throughout the building shall be the same message.

J. Power Requirements:

1. The control unit shall receive AC power via a dedicated circuit breaker.

2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 4 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.

3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.

4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously while incoming power is present.

5. The system batteries shall be supervised so that a low battery or depleted battery condition or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.

6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control

7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.

K. Ancillary Functions:

1. The fire alarm control panel shall have programmable LED’s that include (1) Yellow status indicator light that shall allow the following:
   a. City Disconnect
   b. Fan-shut down bypass
   c. Elevator recall
   d. (4) Spare

2. The fire alarm control panel shall have programmable LED’s that include (1) Red LED lamp to indicate the status of the following:

a. Elevator primary recall
b. Elevator secondary recall
c. Elevator Fireman's hat
d. (4) spare

1.5 SUBMITTALS:

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.

C. Wiring schematics from manufacturer.

D. Shop drawings showing system details including location of FACP, all devices, circuiting and details of LCD annunciator.

E. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.

F. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, sensor, and auxiliary control circuits.

G. Operating instructions for FACP.

H. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.

I. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.

1.6 CLOSEOUT SUBMITTALS:

A. Submit closeout submittals in accordance with Form 816 Article 1.20-1.05.02, NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE:

A. Source limitations: Obtain products from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01

B. Installer Qualifications: A factory-authorized installer is to perform the work of this section.

C. Each and all items of the Fire Alarm System shall be FM Global approved and listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

D. Conduct a Pre-Installation Meeting at the Project Site in compliance with the requirements of Form 816 Article 1.20-1.05.24 subsection 2.

1.8 DELIVERY, STORAGE AND HANDLING:

A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.

1.9 WARRANTY:

A. Refer to Form 816, Article 1.20-1.06.08, and the NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

PART 2 - PRODUCTS

2.1 BUY AMERICA COMPLIANCE

A. Products must meet Buy America requirements. Refer to NOTICE TO CONTRACTOR – BUY AMERICA for additional information

2.2 FIRE ALARM CONTROL PANEL (FACP):

A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems" and FM Global 3010 as well as Data sheets 5-40.

B. The following FACP hardware shall be provided:

1. Power Limited base panel with red cabinet and door, 120 VAC input power.
2. 200 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. 200 points of Network Annunciation at FACP Display when applied as a Network Node
4. 200 points of annunciation where one (1) point of annunciation equals:
   a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
   b. 1 LED on panel or 1 switch on panel.
5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FCP LCD Display.
6. Modem connection to municipal 911 service.
7. One Auxiliary electronically resetable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
8. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
9. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
10. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
11. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
12. The FACP shall support (6) RS-232-C ports and one service port.
13. Service Port Modem for dial in passcode access to all fire control panel information.

C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

E. Voice Alarm: Provide an emergency communication system, integral with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:

1. Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems." Amplifiers shall provide an onboard local mode temporal coded horn tone as a default backup tone. Test switches on the amplifier shall be provided to test and observe amplifier backup switchover. Each amplifier shall communicate to the host panel amplifier and NAC circuit voltage and current levels for display on the user interface.
2. Dual alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by use of the central control microphone. All announcements are made over dedicated, supervised communication lines. All risers shall support Class B wiring for each audio channel.
3. Eight channel digitally multiplexed audio for systems that require more than two channels of simultaneous audio. Up to 8 channels of audio shall be multiplexed on a style 4 twisted pair.
4. Emergency voice communication audio controller module shall provide up to 32 minutes of message memory for digitally stored messages. Provide supervised connections for master microphone and 1 remote microphone.
5. Status annunciator indicating the status of the various voice alarm speaker zones and the status of fire fighter telephone two-way communication zones.

F. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 Class B supervised serial communications channel (SLC):

1. Amplifiers, voice and telephone control circuits
2. Addressable Signaling Line Circuits
3. Initiating Device Circuits
4. Notification Appliance Circuits
5. Auxiliary Control Circuits
6. Graphic Annunciator LED/Switch Control Modules

2.3 EMERGENCY POWER SUPPLY:

A. General: Components include battery, charger, and an automatic transfer switch.

B. Battery: Sealed lead-acid. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 4 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 15 minutes.

2.4 ADDRESSABLE MANUAL PULL STATIONS:

A. Description: Addressable single- or double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.

B. Protective Shield: Provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. Lowering and realigning the shield shall silence the horn. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery. Provide and install pull stations as shown on the drawings.

2.5 SMOKE SENSORS:

A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24 VDC, nominal.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
7. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
9. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP.

Sensor address shall be located in base to eliminate false addressing when replacing sensors.

10. Removal of the sensor head for cleaning shall not require the setting of addresses.

B. Type: Smoke sensors shall be of photoelectric. Where acceptable per manufacturer specifications, ionization type sensors may be used.

C. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.

D. Duct Smoke Sensor: Photoelectric type, addressable, sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.

1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
4. Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
5. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
6. Duct sensor shall be housed in a separate weatherproof gasketed enclosure.

2.6 HEAT SENSORS:

A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting unless noted as 200 – deg F fixed on plans.

B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.

C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.

D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

E. Provide where indicated on drawings, Fixed temperature detectors in mechanical rooms or other hazardous areas. Provide rate-of-rise detectors for storage rooms.

2.7 PROJECTED BEAM TYPE SMOKE DETECTORS:

A. Provide with different sensitivity settings

B. Beam detection shall be provided with transmitter and detector.

C. Provide remote indicator panel for each set of beam detectors.

D. Easily adjusted optics with internal sighting mechanisms for simplified alignment.

E. Long range operation that will allow temporary blockages such as cleaning activities.

2.8 ADDRESSABLE CIRCUIT INTERFACE MODULES:

A. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of non-addressable devices, and for control of evacuation indicating appliances and AHU systems.

B. Addressable Circuit Interface Modules will be capable of mounting in a standard 4”x4”x1-1/2” electric outlet box. Modules will include cover plates to allow surface mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required. Cover plates shall be provided by the Contractor and shall include port holes in the cover to visually monitor the LED status.

C. There shall be the following types of modules:

1. Type 1: Monitor Circuit Interface Module:
    a. For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.

b. For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.

2. Type 2: Line Powered Monitor Circuit Interface Module
    a. This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.
    b. This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.
3. Type 3: Single Address Multi-Point Interface Modules
    a. This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
    b. This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
    c. This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.
4. Type 4: Line Powered Control Circuit Interface Module
    a. This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

D. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.9 ALARM NOTIFICATION APPLIANCES:

A. Notification Appliances: The Contractor shall furnish and install Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).

1. Notification appliance operation shall provide power, supervision and separate control of speakers and strobes. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation.
2. Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; "T" Tapping shall be permitted. Up to 63 appliances can be supported on a single channel.

B. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 75cd and 110cd where indicated. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

C. Audible/Visible: Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.

1. Audible portion shall be a speaker.

D. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

1. Report faults to the host FACP.

2. On-board Yellow LED provides module status.
3. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

E. Accessories: The contractor shall furnish the necessary accessories.

2.10 NAC POWER EXTENDER:

A. The Controller shall be a stand-alone panel capable of powering a minimum of 3 Signaling line circuits. Each channel shall be rated for 2.5 amps and support up to 63 notification appliances. Power and communication for the notification appliances shall be provided on the same pair of wires.

B. SLC notification appliance circuits shall be Class B Style 4.

C. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.

D. The NAC extender panel may be mounted close to the host control panel or can be remotely located.

2.11 MAGNETIC DOOR HOLDERS:

A. Magnetic door holders shall be made from high quality die-cast aluminum and finished with a black powder coat finish. Devices shall be robust, attractive, and compact.

B. Magnetic door holders shall keep fire/smoke doors open and release them in the event of a fire alarm condition.

C. The door holders shall consist of two parts, the electromagnet and the counter plate. The electromagnet is wall or floor mounted and the counter plate is fitted to the door.

D. The operating voltage shall be 24VDC and the fire alarm panel door holder power supplies shall be integrated into the fire alarm control panel.

E. Holding force shall be a minimum of 100kg.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

1. Factory trained and certified personnel.
2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
3. Personnel licensed or certified by state or local authority.

C. The new fire alarm system and all related equipment required is designed and detailed within this specification and will be installed. The Contractor is responsible for any other equipment required which may not be detailed in the drawings or listed within the specification shall be installed for proper installation and operation of the new system. This includes all device backboxes and cover plates where required.

3.2 EQUIPMENT INSTALLATION:

A. Install a complete Fire Alarm System as described herein and as shown on the plans. Include all other necessary material for a complete operating system.

B. Duct Smoke Detectors: Comply with manufacturer’s written instructions:

1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity of the existing air handling system.
2. Verify that the fan shutdown relay is rated to interrupt the existing air handling system fan motor control circuit.
3. Install sampling tubes so that they extend the width of the existing duct.

C. Monitor Modules: Mount within electrical boxes near the sprinkler waterflow, pressure, and/or tamper switches. Coordinate location and interconnection with the sprinkler system. Remove existing steel boxes in Garage areas and provide and install NEMA 12 boxes with a gasket for the monitor module cover.

D. Control Relays: Mount within existing electrical boxes as recommended by the fire alarm manufacturer.

E. Manual Pull Stations: Surface mount pull stations in back boxes. Mount new pull stations so that top of pull station is 48” above finished floor, as per ADA standards

F. Fire Alarm Control Panels: Install so that the top of the cabinet is not more than 72 inches above the finished floor.

G. Isolation Modules: Where called for on plans install in same location as existing device to be removed.

H. Remote Annunciators: Install per manufacturer's recommendations. Mount at height so that LCD is viewable.

3.3 WIRING INSTALLATION:

A. System Wiring: Wire and cable shall be a type listed for for intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the latest edition of NFPA 70: National Electric Code (NEC).

B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. The Contractor shall make no deviation from the written instruction without the prior written approval of the Fire Alarm System Manufacturer.

C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red. Provide and install wire numbers and number terminal strips.

3.4 FIELD QUALITY CONTROL:

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pre-testing, final testing, and adjustment of the system.

B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

1. Factory trained and certified.
2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

C. Pre-testing: Determine, through pre-testing, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.

H. Final Test, Certificate of Completion, Certificate of Occupancy, and first annual inspections:

1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.
2. Provide the first annual fire alarm inspection as required by NFPA 72.

3.5 FINAL ADJUSTING:

A. Occupancy Adjustments: When requested within the one year of date of final acceptance, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to (3) three visits to the site for this purpose.

3.6 TRAINING:

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 4 training sessions each two hours long in duration.
2. Schedule training with the Owner at least seven days in advance.

3.7 WARRANTY:

A. Warrant that the Products be free from defects in material and workmanship under normal use for a period of one year from the date of final project acceptance of all or any part of the system. Supplier shall warrant that any software supplied under this contract, as well as that software contained in or sold as part of any product supplied, will conform to its published specifications in effect at the time of delivery and for one year after final project acceptance.

END OF SECTION 283101