Lessons Learned
Catenary Work Items

1.) TEMPORARY CONDITIONS: Bridge Plates – Item #0090061 was increased by 76 cycles due to a quantity shortage in the original estimate. Additional bridge plates were requested by MNRR at the Rye and Port Chester stations, via CO O6 "R". It is recommended that a comprehensive review with the Railroad regarding the number of plates for each station be conducted prior to the bid, and a contingency of approximately 10% -15% of the estimated quantity be added to accommodate unforeseen requests.

2.) TEMPORARY CONDITIONS: Lowering of Existing Catenary – MNRR did not approve the type of temporary hangers that were shown on Drawing L-15 when submitted by the Contractor. Their argument was that since the existing contact wire was fastened in a rigid manner to the messenger wire(s), MNRR desired that the temporary condition be capable of providing that same level of rigidity. As a result, MNRR accepted a proposal by the Contractor to fabricate hangers from two pieces of trolley (contact) wire. Standard MNRR parts were used to attach them to the existing catenary and common Crosby style u-bolts were used to join the two pieces together. This enabled the hanger length to be adjusted in the field (see attachment "A", sketch #2). This method worked well and pleased the Railroad. However, had the Engineer previously been made aware of the Railroad's dissatisfaction with the hangers shown on Drawing L-15, the Change Order Item #O6A0002 would have been avoided.

3.) TEMPORARY CONDITIONS: Lowering of Existing Catenary – There was an apparent conflict between the Engineer's linear foot quantity estimate and actual distance required to achieve the specified contact wire temporary transition gradient. The Project did not have the Engineer's estimate back-up available to it, but does recommend that a careful review be made between the pay limit wording in the Special Provisions verses the specified temporary contact wire gradient given (see attachment "A", sketch #1). The addition of Change Order Item #O6B0001 may have been avoided, at least in part, had this been addressed prior to bid. It is also recommended that the Engineer eliminate the conflict regarding the temporary gradient given on page 196 of the Special Provisions, which differs from that given on Drawing L-15, which also differs from the value in Note 11 on Drawing G-8. In an effort to reduce cost, the Project used the less stringent gradient to lessen the linear feet lowered as much as possible.

4.) TEMPORARY CONDITIONS: Pull-off Supports – At certain curve locations as the existing track 1 catenary was removed, the Project had a costly learning experience in ensuring the existing in-service track 3 pull-off's did not sag and foul the train's pantograph. The existing track 1 wire was actually supporting the existing track 3 pull-off's. This was usually due to a lack of adequate tension in the existing pull-off wires. When the track 1wire was removed, so was the support (see attachment "B", sketch #2). Temporary support wires via Item #0090069A (V3B10P24) were added. Had this been anticipated prior to the bid process, language in the Removal of Catenary Item

#0096065A could have been changed to include this type of temporary support in the Contractor's bid.

5.) TEMPORARY CONDITIONS: Temporary Cross-overs – One of the most difficult aspects of the Project was making the new Auto-Tension (A.T.) catenary function properly next to the existing Fixed-Tension (F.T.) catenary. This is most difficult at the interlock cross-over tracks, where a F.T. cross-over wire turns out from a A.T. mainline track. The A.T. wire height remains constant, but the F.T. wire height rises and falls with temperature. Tolerances are tight in these "turn-out" areas. In response to this matter, the Project devised a system to prevent the inherent problems of combining the two wire types. By modifying a MNRR deep knuckle assembly with extra hangers going from one wire run to the other, combined with movement restrictions placed at the A.T. wire balance weight, the problem was solved (see attachment "C"). Utilizing this method offered the advantages of A.T. catenary while minimizing the risks associated with sagging and hogging (rising) of the existing F.T. system. It is recommended that this procedure be passed on for use in future projects.

6.) INSTALLATION OF NEW CATENARY SUPPORT STEEL: For New Catenary Trusses – An alternate drop tube fabrication issue resulted in an extra cost to the Project. This matter was based primarily on confusion during the submittal review process. The design drawings contained an alternate drop tube detail for use in those few special cases where the normal drop tube could not be attached to a catenary support trusses due to local conditions (splice plates, etc.) on the trusses that would impact attachment of a normal drop tube. The Designer had intended that the standard drop tube design be utilized in all other locations. When the Contractor submitted his shop drawings for these alternate drop tubes, they were approved with the Designer understanding the approval was for limited use as intended. However, the Contractor took the approach that he was permitted by contract to use these alternate drop tubes throughout the project and placed an order to build them. By Field Directive, the Contractor was instructed not to use the alternate method except where normal drop tubes could not be mounted, and to fabricate standard drop tubes for the new trusses using materials designated for existing trusses. The Contractor was compensated for some wasted material and additional fabrication time. It is recommended the drawings and specifications be altered to eliminate this claim.

7.) INSTALLATION OF NEW CATENARY SUPPORT STEEL: New Trusses – Another problem faced with the new trusses was that the horizontal member is fabricated in three separate sections. The splices did not appear on the drop tube installation drawings and often modifications to mounting were required. In particular was the installation of the large TDS and CDS assemblies. The actual support pieces are so large that the plans do not always take into account their size. A great deal of custom mounting and field drilling and bolting had to take place. It is recommended that the splice locations and size of the CDS and TDS mounting steel be reviewed during design when allocating assemblies and positions on the new trusses.

Lessons Learned
Catenary Work Items

8.) INSTALLATION OF NEW CATENARY SUPPORT STEEL: Removal of unused Signal Heads – Item #0096067A did not specify other associated existing steel components on the trusses which were in conflict with drop tube installation or that MNRR had ultimately wanted to be removed. These components were present in association with obsolete signal heads themselves and other related components such as cable trays, walkways and ladders that had to be removed at an extra cost to satisfy MNRR. It is recommended that language be included in the Item to specifically note these removals shall be a part of the base contract.

9.) INSTALLATION OF NEW CATENARY SUPPORT STEEL: Anchor-bridge Obstructions – The installation design had anticipated that by the time of bid, existing switchgear and electrical hardware located on anchor bridges was to have been taken out of service and removed by MNRR prior to the start of the Project. This had been discussed during design and the contract prepared accordingly. As a result of project timing the material was still in place and was encountered in the field. A large amount of drop tube mounting steel at these locations had to be customized in the field resulting in additional changes under Item #0090069A. It would be recommended to either confirm independently that MNRR has completed their anticipated scope of work prior to bidding, or insert appropriate bid item language to specifically include the cost of developing custom mounting steel to accommodate the existing obstructions at anchor bridges.

10.) INSTALLATION OF NEW CATENARY SUPPORT STEEL: BWA Support Angles – The project encountered a problem with Balance Weight Assemblies (BWA's) slipping down on the catenary structure columns when the dead load of the weights was applied. Support angles were added to prevent this slippage via Item #O6J0001A. The support angles should be shown on the contract drawing and become part of the base quantity.

11.) INSTALLATION OF NEW CATENARY SUPPORT STEEL: Registration Safety Boot – The notation that this boot is required only if electrical clearance was reduced was changed by MNRR's request. The said insulating boot was ultimately required on all RA-120 type registrations. Removing this note in the future is recommended.

12.) INSTALLATION OF NEW CATENARY WIRE: Long-term Outages – There were initially some misconceptions on the part of a number of individuals regarding signal blocks and how these blocks relate to outages and catenary wire runs. Looking at contract drawing L-19, we can see how the railroad perceived that the outage phases should be conducted. A full understanding of these relationships was gained by the Project over time, and the following information may be beneficial for use in the planning of future work. The Project's interlock (Green) is shown on the referenced drawing. In simple terms, the sketches on the drawing could lead one to assume there is a west block and an east block, which there are. However, the interlock itself is its own third block, and the outages required to complete work in that third block are not specifically shown on this drawing. In addition, the two inside tracks are configured electrically different than the two outside tracks. The electrical separation is accomplished through catenary insulated overlaps. The nature of these catenaries is such

that they must extend into the adjacent electrical section in order to terminate. To complicate matters, the outside tracks do not have the same electrical separation points as their signal separation points, so limits of outages will be impacted. This starts to get very detailed, attachment "B", sketch #1 is offered to try and illustrate this point. In summary, future projects might well consider additional diagrams and outage phases in a manner which reflects these complex field conditions. Many complications for the Project arose out of additional outage requests that were not fully understood by MNRR's downtown management, due to the fact they were not specifically diagramed and understood in the planning phase.

13.) INSTALLATION OF NEW CATENARY WIRE: Grounding – The Project encountered an incident where a tail wire burned and broke. Two grounded wires arcing together caused the burning. It was determined that it is not enough to simply ground the wires to the structures when two wire runs are under construction at overlaps. In this particular case, one wire run was grounded to a truss and the other to a completely separate truss. There was debate on the actual cause, but it is suggested that the two wires developed an electrical potential difference (voltage) between them and they were only inches away from each other. As trains passed at night, the two "grounded" wires touched, and though this should not have been a problem, it in fact caused one of the wires to burn through and then break. In a completed installation, the full feeding "A" type jumpers ensure that the two wire runs are fully bonded together. From that point in the Project, this problem was dealt with and solved by ensuring that temporary "A" type potential jumpers be installed immediately in such cases. This is recommended as a strategy to be passed on to future projects. Aside from clearance distance and insulation material, other methods can be utilized to reduce unwanted potential build-up and are recommended. Any induced current must have an unobstructed path to drain. Therefore, it is important to ensure that the Contractor's working grounds are applied firmly to the trusses, that the trusses are positively bonded to the static wire. Verifying that pull-off insulators are not leaking current through them, possibly through the use of infrared technology is also recommended.

14.) INSTALLATION OF NEW CATENARY WIRE: Tensioning with In-span Insulators – One of the most difficult aspects of the Project was encountered with twisted in-span insulators. During investigation and research, the Project learned that all of the braided wire specified for the catenary work increases in torsion as the tension is increased. Often, common swivels do not relieve this build-up of torsion due to the many angles and turns the braided wire may make. The nature of catenary wire installation lends itself to this torsion build up, in general it must be expected due to the fact the final tension can not be applied in a practical manner during the first installation step, particularly on an inside track. Different wire types or braiding methods may have to be explored if specifications remain the same.

15.) INSTALLATION OF NEW CATENARY WIRE: Overlaps – The Project was faced with a redesigning of the overlap installation drawings to be more in-line with the basic design principles noted in Drawings L-1 to L-7. Installation had started prior to redesign and correcting the track 4 overlaps in the field was difficult and costly. A more intensive review is understood to occur as a result of this lesson.

16.) INSTALLATION OF NEW CATENARY WIRE: Overlaps – Overlaps in curves should be avoided. Radial loads, stagger and mid-span off-set problems were constantly present. Parts had to be added, steel moved and moved again, takeovers were difficult to make smooth, as the contact wire often went out-of-running too quickly or oddly.

17.) INSTALLATION OF NEW CATENARY WIRE: Balance Weight Assemblies (BWA's) – Several lessons were learned regarding these assemblies. The "bleeding" of the cast iron through the specified paint on the weight stacks was virtually impossible to control. Therefore, painting of cast iron is not recommended in the future. There were several revisions to the E-9 drawing relating to problems encountered on the Project, we recommend the mean temperature of 60 degrees F at the bottom of page 206, Item #0096050 be changed to 70 degrees F. In addition, the Project developed several methods to ensure the weights functioned as intended. A comprehensive checklist and review process was used to ensure that no binding would occur in the operating temperature range. By encapsulating some of the truss bases in concrete, the space for the weight stack was reduced, so the extra checks were required. It is also very difficult to get the outer-most pulley into the design position. Therefore, this required an extra check too. Another note to pass on is when setting the cold stop, take in two extra inches of slack than calculated, it will stretch. The Project would recommend that after the pre-tensioning process takes place, it is realized and understood that the final tension is set up by the weights, not the men with the hoists. The Railroad is so used to working with Fixed Tension systems that they tend to put too much emphasis on the tension prior to the weight being placed. Lastly, the system after installation simply needs time to adjust itself because of cable stretching and such. The Project recommends that the balance weights initially be installed close to where they should be, but final adjustments should be made after some time passes. Also, future Projects should be aware that one can walk up to an installed weight stack and "pull it down" over a foot if they add their own bodyweight to it, but the stack won't go back up "right a way". Therefore, it is important that critical measurements are never taken in this state (closely following any change in weight or position), otherwise when you come back the next day the weight position will be wrong.

18.) INSTALLATION OF NEW CATENARY WIRE: Section Insulators – These units have a minimum system depth where they can be used, the Project encountered a problem with this. The limitation depends on the manufacturer. These insulators also need to be installed on a wire with a negative pre-sag, which was not specifically addressed on the hanger tabulations. Hangers were often allocated right where the unit must be installed. The Project recommends that the parties involved (hanger generator, allocation designer and manufacturer) become more coordinated in the proper installation designs for these critical assemblies.

19.) INSTALLATION OF NEW CATENARY WIRE: Mianus River Bridge – The tension reducer that was originally designed to provide a smooth profile for the pantograph at the bridge catenary air gap did not work. It pulled on the contact wire and created a hard spot. There was a great deal of re-engineering and the new hanger tabulations and redesigned safety device did not solve the problems encountered in the field. The project resolved this matter by utilizing various standard components combined in a manner that achieved smooth passage and a suitable safety device that satisfied the Engineer's intent. In summary, the Engineer approved RHA-3 hangers to be field adjusted and a modified THB assembly that was used as the in-running safety device. The Project would not recommend the use of an in-running tension reducing device in the future.

20.) INSTALLATION OF NEW CATENARY WIRE: Mianus River Bridge – The messenger wire in the first span on either side of the bridge air gap was designed to be in fixed tension. A COI was issued to clarify tensions to be used, insulator types & bracing were changed to accommodate the higher tensions that could be present as the temperature lowers. There was significant rework involved that generated Item #O6N0007. Therefore, the Project would recommend that any fixed tension sections inserted into the Auto-tension catenary be assured to have the above issues pre-addressed.

21.) INSTALLATION OF NEW CATENARY WIRE: Over-Bridge Drip Shields – Where road bridges pass over the tracks, the original design concept did not include shielding to protect the catenary from ice, etc... Metro-North later demanded that this be added to all projects. In most cases, the contact wire was originally forced to be at its lowest possible position (16'- 0" min.) due to the bridge being low and to maintain electrical clearances. With the introduction of shields, the limited space was reduced even more. Several assemblies had to be modified and customized to accommodate this. The Project would recommend these Drip Shields be designed in and the clearances checked during design now that Metro North has determined shields are a required feature.

22.) INSTALLATION OF NEW CATENARY WIRE: End wrapping of Copper Jumper Wires – Item #0096050A (A.T. Catenary) did not identify any specific type of material to be used as an end wrap on page 210, par. 2. The Contractor used electrical tape to the dissatisfaction of the Railroad. Wires that had steel as a component had their ends lashed with standard lashing material. The steel lashing could not be used on copper wires due to the reactive chemical nature. The Project went back and forth with the Contractor on this issue, and it was never fully resolved. The Contractor argued that it was not common lineman practice to lash copper jumpers because they were not a normally part of lineman work. It is recommended that copper wire lashing or other compatible material be specified in advance to avoid this conflict in the future.

23.) INSTALLATION OF NEW CATENARY WIRE: Bi-metallic materials – The Project prompted a better understanding of the need for ensuring aluminum products are isolated from components made with copper. The Engineer has since specified that components containing copper must be "tinned" prior to being attached to aluminum coated wire and such. There were changes via Item #'s O6N0004 & O6N0005 associated with this lesson.

24.) INSTALLATION OF NEW CATENARY WIRE: Pull-off's – It is recommended that double span wire pull-off's not be used unless absolutely necessary. Working with these pull-off's in the field, it was discovered that a single span pull-off can accommodate a larger system depth than shown on the drawings, in-turn enabling the Project to eliminate several double wire types. The basic design does not consider the heel setting or the slight sag which normally occurs due to the weight of the assembly. This essentially enables the single wire type to handle system depths of approximately 22". It is recommended that the single wire type be allocated for system depths up to that value. We found that a 24" system depth required a double wire assembly, but a 23" depth could be effectively pulled by the single wire span. See attachment "D" to better understand this and the issue of Field Directive #112. The allocation of these assemblies is directly related to the Engineer generated hanger tabulations. The actual system depth to be encountered is somewhat estimated by the Engineer during the design phase. This estimate is used to determine the type of assembly to be allocated and the height of the span bracket(s) supporting the pull-off wires. Once the Contractor is sure of his field conditions, he then orders the hanger tabulations from the Engineer. It is not until the hanger tabulations come back from the Engineer that the Contractor is sure of the system depth that will actually be installed in the field. In short, the elimination of rework (see attachment "E", sketch #2) on the bracket installation (to achieve the correct height) and all of the extra work (twice as much) involved with the double wire pull-off may be avoided if the estimated hanger tabulations were analyzed more closely ahead of time.

25.) INSTALLATION OF NEW CATENARY WIRE: Contact Wire Kinks – As specified, kinks in the contact wire that prevent smooth pantograph passage are not allowed. The methods described in the specifications to remove kinks were enhanced by the Contractor's introduction of a hand-held contact wire straightener. The Project recommends continued use of this device. In addition it is noteworthy to point out the many factory contact wire silver solder type splices found. Most wire runs had two or three of these, some had up to four. Although the strength of these splices is not in question, the kinks that result from these splices are an issue. The manufacturing process often produces kinks that even the Contractor's "roller" device could not effectively remove. The Project recommends that an investigation take place as to why these "factory" kinks occur, and what can be done to prevent them. The answer may be to specify that no factory splices be allowed in the future. It is also noted that the Contractor can often kink the wire during the installation process by using temporary support ropes on the contact wire with too much load on them, also by attaching steady arms incorrectly. The Project recommends that close attention be placed on these activities to reduce contact wire kinks.

26.) INSTALLATION OF NEW CATENARY WIRE: Hangers – When the Contractor proposed that he would manufacture a jig to complete one end of the factory made hangers, there was great skepticism. As it turned out, this was in fact very beneficial to the Project. To be able to quickly make a hanger to spec. in the field proved most valuable. The continued use of this method is recommended.

27.) INSTALLATION OF NEW CATENARY WIRE: Assembly Shop Drawing – The CDEA-5 assemblies had an improperly documented change that appeared to be generated by the manufacturer. This caused enough confusion with the MNRR catenary inspectors to note it here. The Project recommends that this drawing conflict be corrected. A different style turnbuckle was introduced by the Dossert Co., and that style appeared to eliminate the need for another component (Part #86) that was allocated to be in the assembly. However, the changed assembly shop drawing was never re-issued to the Project. Attachment "E", sketch #1 is given to better illustrate the recommendation.

28.) INSTALLATION OF NEW CATENARY WIRE: Inspection – Due to the weight of the steady arm (all changed to Schedule 80 for our Project) and the proper placement of the hangers, the system heights were almost always 2 to 3 inches larger than predicted and indicated on the drawings. The messenger wire should be set once and not constantly adjusted to satisfy the negative contact wire tolerance of zero (0) inches given in the specifications. Lock washers loose their effectiveness when re-used. The field installers and inspectors should be experienced in this work and recognize that in order to obtain the contact wire heights & tolerances given, all messenger wire assemblies should initially be installed 3 to 4 inches higher than shown. That in-turn may cause clearance problems at some of the trusses. If gradient and minimum contact wire height tolerances are met, the Project recommends that a negative tolerance for the contact wire be allowed in the future.

29.) INSTALLATION OF NEW CATENARY WIRE: Inspection – The installation design often was in conflict with the 7" pantograph up-lift clearance requirement. When security hanger, MCIA-2 and Type "A" jumper assemblies, were installed exactly as shown on the plans, often the clearance was still not met. This required a great deal of adjusting in the field, at times we were forced to allow less than 7" of clearance. Therefore, the Project recommends Engineering to look into this. Discussions with the Electrack engineer proved that they were not fully aware of the 7" requirement listed in the written specifications. As a follow-up note: Security hangers and MCIA-2's are at their worse case at 15 degrees F., and if set up correctly, the Type "A" jumpers are at their worse case at 70 degrees F.

30.) INSTALLATION OF NEW CATENARY WIRE: Inspection – The pantograph clearance gauge as described in Item #0090046A is not practical. The platform truck used with a mounted pantograph and clearance gauge information was more useful and ensured the end product functioned as intended. The safety shield on the high rail platform turned out to be more of a hazard on, than off. The MNRR Class A Groundman offered the best means of protecting inspection personnel. The mock pantograph should be metallic and grounded to the high-rail vehicle chassis, as it acts as a traveling ground.

31.) INSTALLATION OF NEW CATENARY WIRE: Inspection – When the ambient air temperature was approximately zero degrees F., the catenary wire was at its low temperature limit of 15 degrees F., the cold stops should be engaged at this point. The Project never saw the catenary wire go over 100 degrees F., even during 90+ degree F. heat waves. If a jumper had to have some slack taken out in order to provide adequate pantograph clearance, it was taken from the hot side, never the cold side.

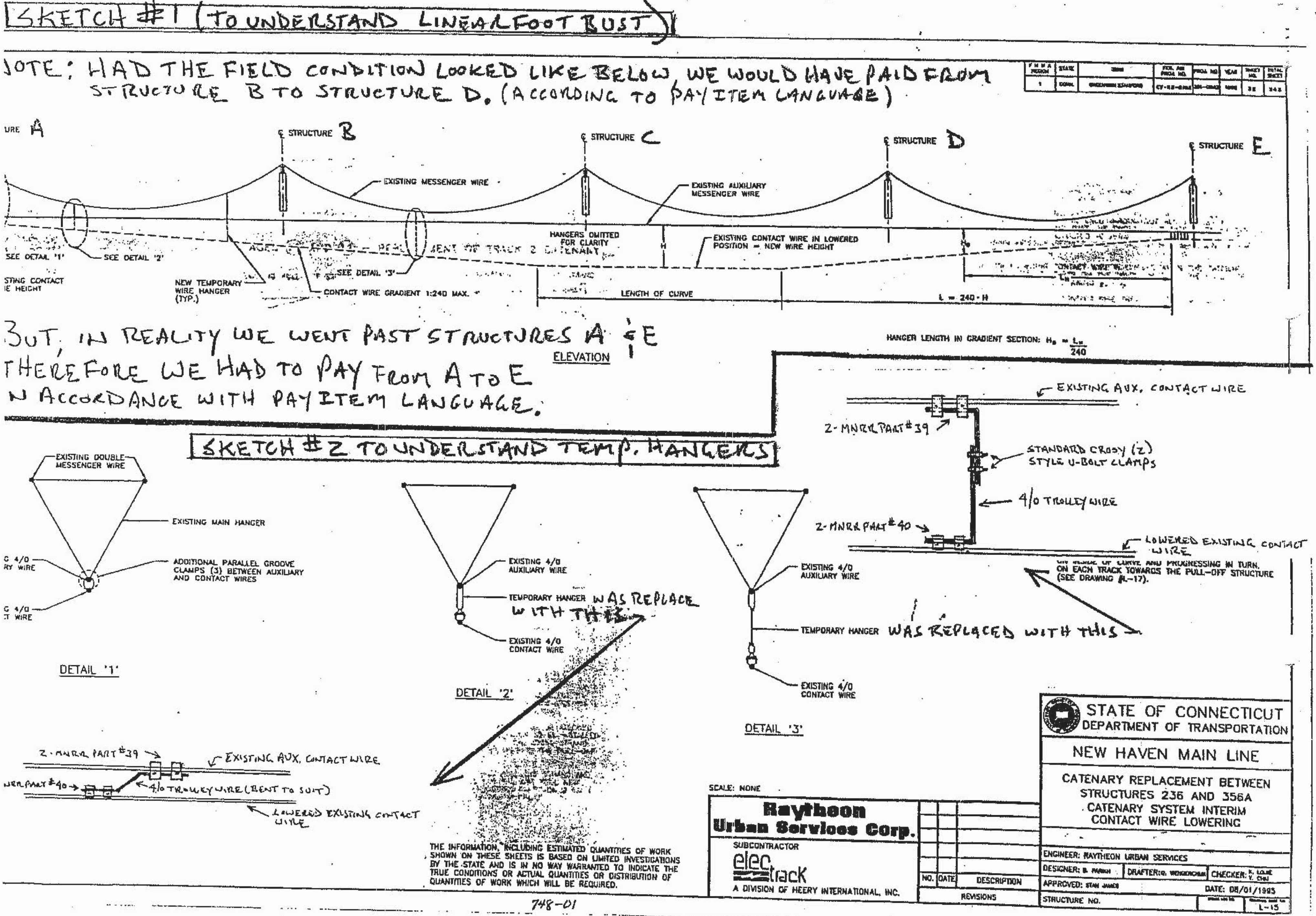
32.) INSTALLATION OF NEW CATENARY WIRE: Inspection – It proved beneficial to enforce the Contractor's requirement to pre-inspect, record and correct his findings prior to CDOT/MNRR final inspections. The Project recommends witnessing that the Contractor is doing this and conducts an audit of his records to ensure the results have been recorded. The final trolley level inspections should be done jointly with the Contractor and the MNRR representative. In this manner, findings can be discussed and mutually agreed to be placed on the punch list. This ensures that all parties understand the findings and by having the Contractor initial each item and sign the punch list, his commitment to correct them.

33.) INSTALLATION OF AERIAL FEEDERS & JUMPERS: Switches – There were a few noteworthy lessons learned regarding the overhead mechanical switches. It was found to be much more favorable to mount the switches on the uncluttered new trusses as compared to the old. The submitted and Engineer approved shop drawings for the switch mechanism and mounting base did not include pin insulators shown on drawing E-103. The linkage shop drawings were vague which caused inspection problems in the field. In addition, there were field problems with the manual handle type(s) that were submitted and approved, whereas the Railroad wanted a type that the manufacture could not provide. It is recommended that shop drawing reviews be more intensive in order to prevent these types of issues in the future. Lastly, the Part #42 closest to the switch (shown on drawing E-8 for a Type B-500 C jumper) should be slightly cocked to prevent rubbing of the flexible conductor on the messenger wire. Also, when questioned, the Electrack engineer had stated that both Part #42 and #43 could be used interchangeably on the Project switch jumpers, which caused some confusion for the MNRR inspectors.

34.) INSTALLATION OF OVERHEAD FEEDERS & JUMPERS: Dead-ends – Many additional dead-ends were requested by the Railroad that were not shown on the original drawings. This included work on the Mianus River Bridge and at the Greenwich station. Originally, the design showed replaced or lengthened wires to be spliced with a compression fitting to the continuing existing wire(s). To avoid the extra costs associated with these changes, it is recommended that a more active role by the Railroad take place during the design phase to ensure the type of dead-ending they prefer is incorporated into the bid package prior to release. In addition, steel extensions for the 500 MCM jumpers from the structure 310 anchor-bridge were a MNRR afterthought. This extra work also could have been included in the base bid.

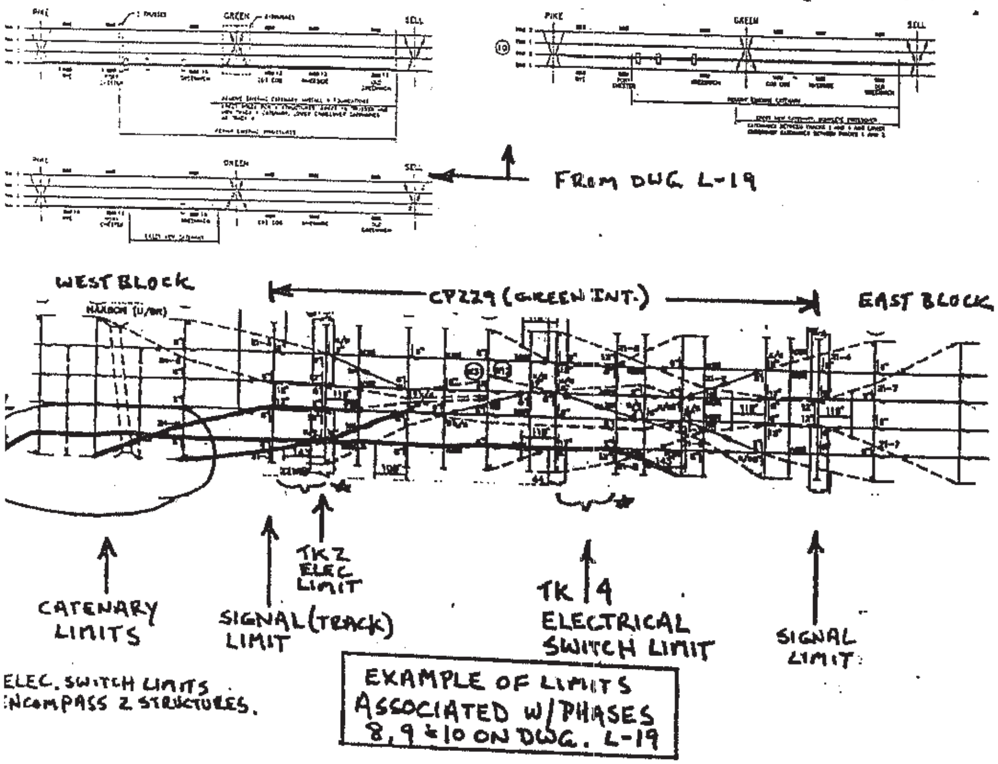
35.) INSTALLATION OF OVERHEAD FEEDERS & JUMPERS: Tensioning of wires – The Project encountered field problems while trying to satisfy tension requirements for certain wires. The major issue was encountered with feeder wires on the Mianus River Bridge. In addition, there were problems with the tensions in the along track switch jumpers above the messenger wires on the same bridge, which was addressed through COI-16. In these cases the problem was two fold, the drawings often directed the Contractor to tension the wires to the same degree as the existing. It is very difficult, if not impossible to accurately measure the existing tension with a standard dynamometer and hoist. The large hoist used for this work increases the tension so much with just one click that it can be a safety hazard when attached to the old wires. If a dynamometer was able to be placed in-line with an existing wire to check the tension, it would be difficult to get the old tension back into the wire so tensions could be read. The second aspect of the problem is that often, the new wire is larger in diameter, thus making the tension issue more difficult because the weight of the new wire makes it sag more in the mid-span position. To get the heavier wire profiled in a similar manner as the old, the tension must be greater than the existing wire. To solve these problems in the field, the actual sag in the mid-span point had to be measured before and after and tensions increased or decreased to get the wire in an acceptable position. Because the high wires are inaccessible at the mid-point, a survey team had to be brought in to measure the sags. It is recommended that this activity be incorporated into the bid package and that the method of tensioning be addressed in detail in the future.

ATTACHMENT "A"



32

ATTACHMENT "B"

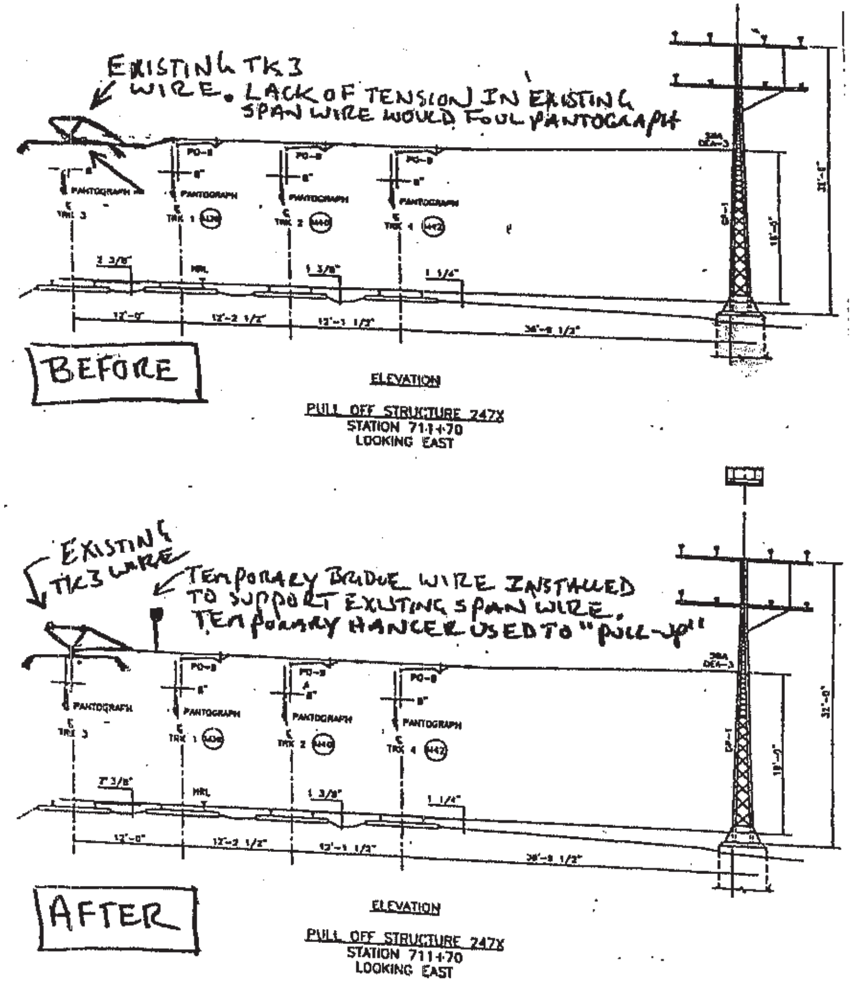


The contract drawings L-18 to L-20 accurately depict the electrical switching limits. They do not clearly indicate the signal (track) limits or the new catenary limits. All of the new catenaries extend beyond the electrical and signal limits as they go out-of-running and terminate.

There are three elements to consider when planning the required outages:

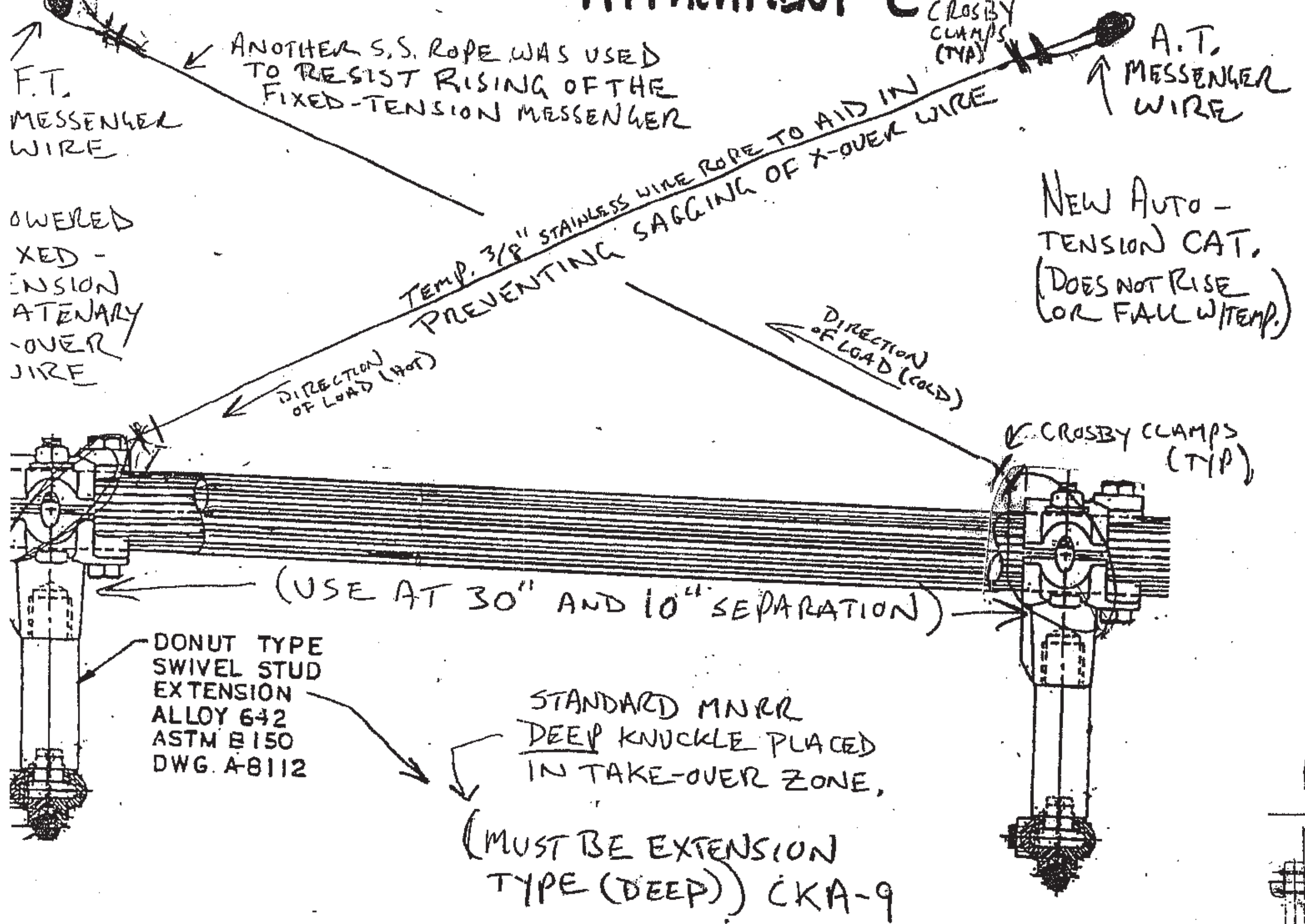
1.) The signal (track) limits.
2.) The electrical limits.
3.) The catenary wire run limits.

SKETCH #1



SKETCH #2

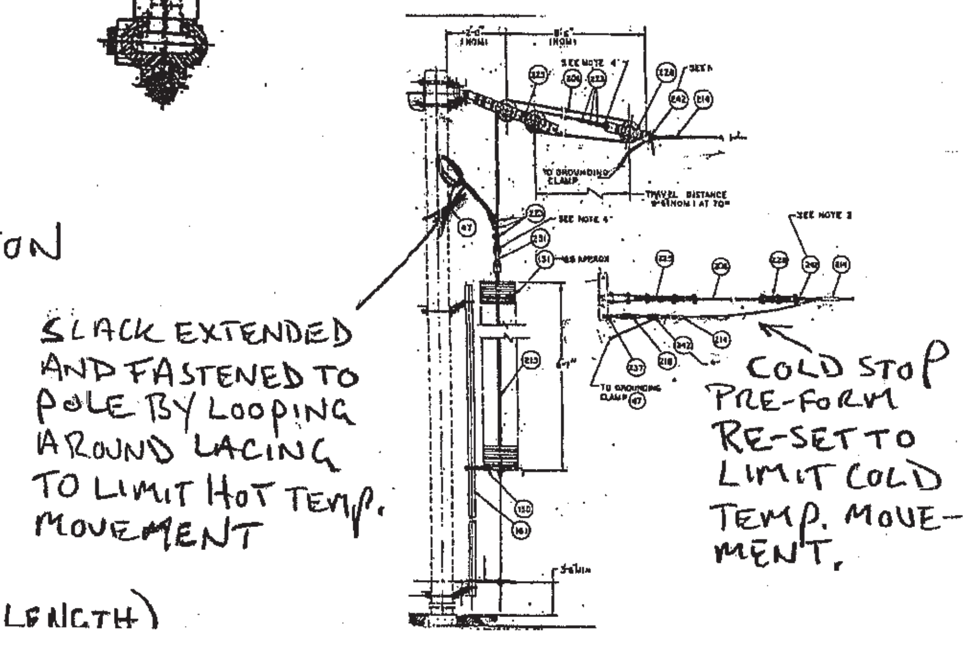
ATTACHMENT "C"



NOTE: IF USED FOR MORE THAN ONE SEASON SPRING AND FALL ADJUSTMENTS REQUIRED.

NOTE: CROSS-OVER WIRE ALSO SUPPORTED FROM CLOSEST STRUCTURE, EVEN IF NEW DESIGN DOES NOT CALL FOR THAT (LIMIT SPAN LENGTH)

AT BWA



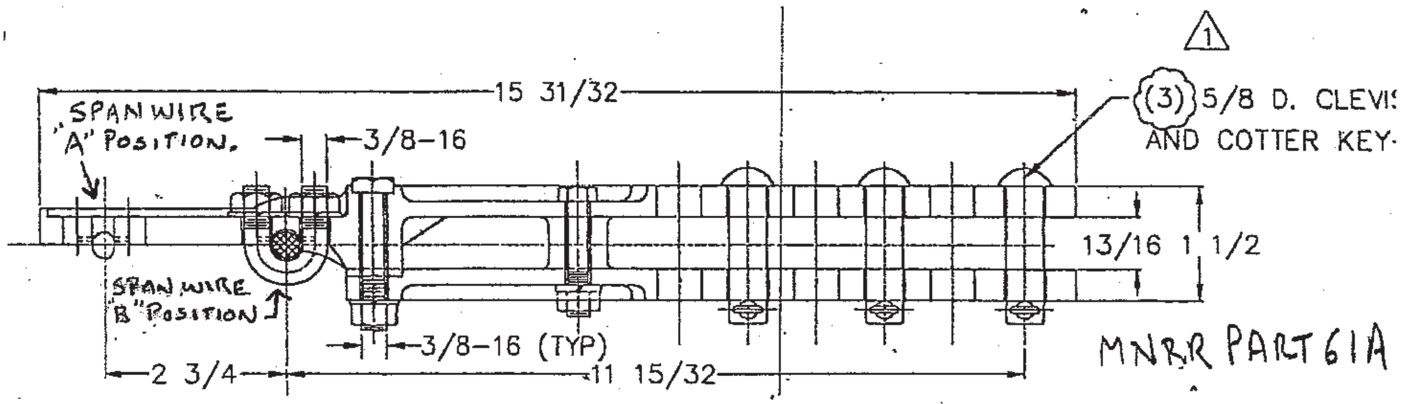
ATTACHMENT "D"

PO-1's & PO-2's as shown on Drawing E-4 can generally accommodate system depths between 18 and 23 inches. This is primarily due to the fact that the PO-6, 9 & 10 shown on Drawing E-7 can accommodate an additional 3 inches of system depth than indicated on the drawing. This just naturally increases the system depth the PO-1 & 2 can handle.

Below are examples of why the pull-off's can be used for larger system depths than the MNRR standards show. Luckily for the Project, many pull-off installation allocations were not in line with the standard, enabling the Project to not have to justify them being installed in a manner that did not conform with the E-4 & 7 drawings.

Note: When span wire is in the "A" position, dimensions add-up to the following when heel distance is included: (2.75" + 11.5" + 2.5" = 16.75").
With the introduction of gravity on the mass of the bracket, the sag in the field (approx. 1.25") enables this PO bracket to accommodate a system depth of 18".

The following could guide the possible revision of drawings E-4 & 7
PO-6: (9" to 12")
PO-9: (12" to 18")
PO-10: (9" to 18")
PO-1 & PO-2: (18" to 23")
PO-3, 4 & 12: (24" and greater)



STR.	TK	MEASURED SYS DEPTH AT P.O	LENGTH OF CLOSEST HANGER	PO ALLOCATED ON ED DRAWING	FIT PER E-DWG?
237X	2	16"	18 1/2"	PO-6	N (+7")
	4	18"	20 1/2"	PO-10	N (+3")
238X	2	20"	21 1/2"	PO-1	N (+2")
	4	21"	21"	PO-2	N (+3")
240X	2	21.5"	22 1/2"	PO-1	N (+3.5")
	4	23 1/2"	22 1/2"	PO-2	N (+5 1/2")
246X	2	22"	20 1/4"	PO-1	N (+4")
	4	25 1/2"	25"	PO-1	N (+7.5") **
247X	2	17"	17"	PO-9	N (+2")
	4	17"	15 1/2"	PO-9	N (+2")

These are examples of Pull-off's whose installation allocations did not conform with the E-4 and E-7 drawings, but were fine in the field. [EXCEPT 246X, TK4).

MEMORANDUM

Metro-North Railroad Bridges in Greenwich, CT
CDOT Project Nos. 56-248, 301-0042/0044

To: Robert J. Mosback Jr.
Resident Engineer
Washington Infrastructure

From: William J. Salwocki
Project Manager
Washington Group

Date: May 23, 2003

Re: PO Assemblies Allocations

We have reviewed the PO assemblies allocated at strs. 239AX and 239BX. Because of the substantial distance the pull off poles are offset from the tracks, we are directing that the pull off assemblies at both of these structures be changed from PO-4s and PO-12s to PO-1s and PO-2s.

These changes are to be noted on the as-builts.

cc: L. Cichowski
F. Chojnicki
J. Pfeiffer
J. Abramo
K. Kelleher
D. Fickinger
R. Woodhouse

MEMORANDUM

Metro-North Railroad Bridges in Greenwich, CT
CDOT Project Nos. 56-248, 301-0042/0044

To: Robert J. Mosback Jr.
Resident Engineer
Washington Group

From: William J. Salwocki
Project Manager
Washington Group

Date: July 7, 2003

Re: PO Assemblies Allocations: Str. 282X

We have reviewed the PO assemblies allocated at str. 282X. PO-1 and PO-2 registration assemblies should be used at this location instead of the PO-4 and PO-12 assemblies as shown on the ED drawings.

These changes are to be noted on the as-builts.

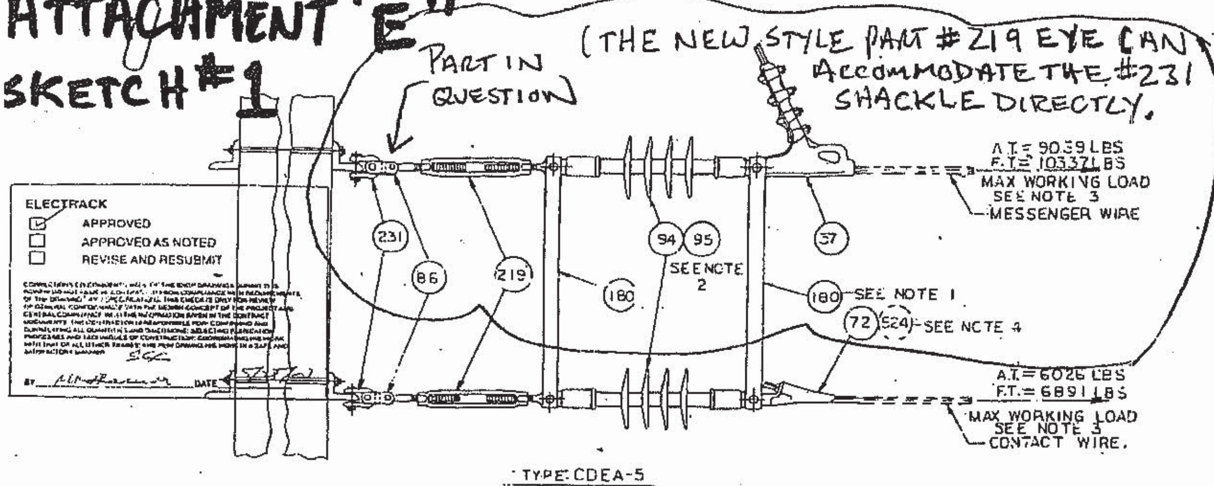
cc: L. Cichowski
F. Chojnicki
J. Pfeiffer
J. Abramo
K. Kelleher
D. Fickinger
R. Woodhouse
T. Holland
filesecA842

State of Connecticut
Department of Transportation
District III, Bureau of Engineering and Highway Operations
Construction Division

Field Directive
Project 56-248

Contractor: Ducci Electrical Contractors
Date: 7-21-03
Subject: Pull-off Allocations at Structures 239AX, 239BX & 282X.
Field Directive No. 112

ATTACHMENT "E"
SKETCH #1



TYPE: CDEA-5

NOTES

1. THE STRAP LENGTH WILL BE EQUAL TO TERMINATION SYSTEM HEIGHT.
2. THE DEAD END ASSEMBLIES WITH 25,000 LB INSULATOR SHALL BE USED FOR A.T. CATENARY SYSTEM. FOR MESSENGER TERMINATION ON F.T. SYSTEM, REPLACE PART 95 WITH PART 94 (2 PL) (136,000 LBS INSULATOR.)
3. MAX WORKING LOADS ARE AT -10° WITH ICE.
4. FOR 4/0 GROOVED AUXILARY WIRE REPLACE P/N 72 WITH 524

PART NO	DESCRIPTION	CATALOG NO	DWG NO.
37	STRAIN CLAMP	SECL50-H-4-RA	D-6957-3
72	DEAD END FITTING	FTDEW-35T	D-6784-1
86	DOUBLE CLEVIS LINK	DCL 63	C-5529-4
94	POLYMER INSULATOR (36,000 LBS)	DLI699 026 VX01	B-8323-1
95	SUSPENSION INSULATOR (25,000LBS)	DLI161 IC1-TT-421	B-7685A-2
180	ANTI TORSION HANGER ASSY	ATH19 150-63-L	D-7249-4
219	TURNBUCKLE EYE TO JAW	TBC 10-32055	B-7794-2
231	ANCHOR SHACKLE	SH 2130-5/8	D-7267-1

7 UPDATE DWG REVS	REV 1 REDRAWN WITH MN P/N	4.8.97
CHG CAT NO DWG REV	REV 2 PART 10 10C CHG D6219-2 TO D7249-2, CHG WORKING	
10 TO 36000 P/N 94 10.1.97	LOAD TO MAX WORKING LOAD ADD NOTE 3	5.8.97
5 CHG P/N 94 CAT NO	REV 3 ADDED NOTE 4 AND BALLOON 524	6.12.97
DWG NO	REV 4 CHG DWG REV ON PN 94, 95	6.26.97

DRAWN ET 4.8.97 | CHECKED 4.8.97 | APPROVED | SCALE

DOSSERT - CORPORATION - ELECTRICAL CONNECTORS SINCE 1904

FIXED TERMINATION (MESS AND CW) ADJUSTMENT AT POLE FTB613 35T AP | DWG. NO. B-7250A | REV. 7

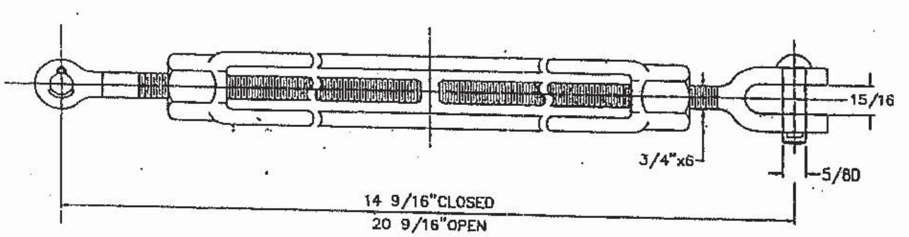
SKETCH #2

EXAMPLE:

Review of Span Bracket Assembly (SBA) design height at structure 276X.

Sta. 276	Sta. 276X	Sta. 277
Contact Wire Height = 17'-2"	Contact Wire Height = 17'-1.5" (less 3" pre-sag) = 16'-10.5"	Contact Wire Height = 17'-1"

After the Contractor installed the bracket as shown on the drawing ED-276X (17'-9" above HRL) during the lowering process, the Engineer then generated the hanger tabulations once the Contractor worked his way over to track #4. The hanger tabulations called for a hanger here to be 16.25" long. Therefore, the messenger wire will be 16.25" higher than the contact wire at this location. That equals 18'-2.75", this is the height the SBA should have been installed, not at the 17'-9" shown on the drawing. That low bracket had then affected the pull-off on all of the other tracks until the Contractor got back to track three to re-work (raise about 6") the height of the bracket.



THIS WAS THE ORIGINAL PART #219, IN WHICH A PART #86 WAS REQ'D WHEN USED IN A CDEA-5

MATERIAL
FORGED STEEL GALVANIZED

CLEVIS PIN
HS. GALV. STEEL

COTTER KEY
STAINLESS STEEL

Metro-North Commuter Railroad

DRAWING TITLE: EYE/JAW TURNBUCKLE 3/4 X 6

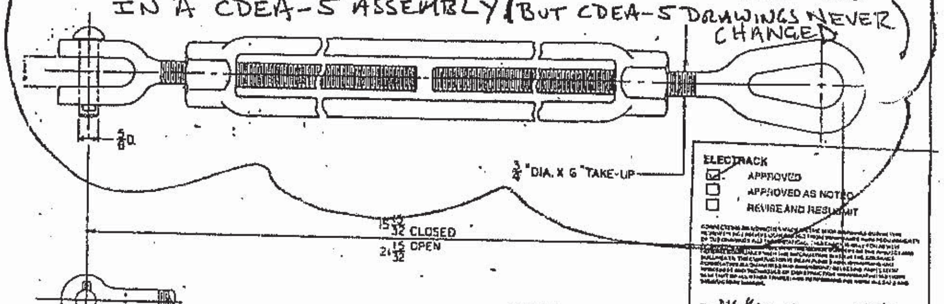
METRO-NORTH NO. 10754361

STANDARD COMPONENTS

ENGINEER: - | DESIGNER: - | DRAFTER: VY | CHECKER: VY | APPROVED: URE

Raytheon

WHEN DOSSERT INTRODUCED THIS STYLE PART #219 DUCCI BEGAN TO ELIMINATE PART #86 IN A CDEA-5 ASSEMBLY (BUT CDEA-5 DRAWINGS NEVER CHANGED)



ULTIMATE LOAD 26,000 LBS

MATERIAL
FORGED STEEL GALVANIZED

CLEVIS PIN
HS. GALV. STEEL

COTTER KEY
STAINLESS STEEL

(219)

REV. 1: CHGD CAT. NO. 11-23-94 | REV 2 CHG WORKING LOAD TO ULTIMATE 4.7.97

DRAWN 10-22-90 CYR.V | CHECKED 10.22.90 | APPROVED 10.23.90 | SCALE

DOSSERT - CORPORATION - ELECTRICAL CONNECTORS SINCE 1904

JAW TO EYE TURNBUCKLE TBC 10-32055 | DWG NO B-7794 | REV 2

Lessons Learned
General Project and Bridge Issues

1) Track Outage Work Times - This project was completed on a heavily traveled section of an active commuter railroad. The bridgework was completed in stages corresponding to the long term track outages. In order to complete work that would foul the adjacent track [or tracks], or that would require either track or side power being taken out, the Contract allowed off-peak track outages for the contractor

   While performing the off-peak outages, it was observed that the start and finish times granted by MetroNorth were not close to the allotted outages in the Contract. To document this lost time; the Field Office developed a Track and Outage Tracking form, which was included on each shift of Inspector Reports. This tracking form was then utilized as a primary document for the first time extension of 96 days of equivalent days of delay, when it impacted critical activities, and/or a long term track outage turnover date.

2) Prior to the start of a long-term track outage, MetroNorth required that all submittals related to critical activities [such as demolition, sheeting, shoring, and H. rail equipment] be approved. Both the Prime Contractor and the Bridge Sub-Contractor were unprepared to meet this requirement for the first long-term outage for track 4 and the scheduled start of all bridge activities was delayed as a result.

   This resulted in the first major claim on this Project. The submitted sheeting plan was rejected by the Designer, as not meeting the specified standards. The Contractor redesigned his sheeting plan from driven sheet piles to a soldier pile and lagging system. The additional time and learning curve to install this system increased the time required for stage 1A and subsequent stages at a lesser extent.

3) The Contractor was required to sub-contract 13% of the Project to MBE or DBE businesses and to provide a list of these at the bid opening. When the Bridge Sub-Contractor submitted Certificates of Title for manufactured steel for the first stage it was noted that the Minority firm identified to supply this material was not being utilized. Prior to being paid for the materials **all** of the Titles had to be re-issued, joint checks had to be issued and Minority participation was verified. It is suggested that this activity be very closely monitored on future projects as the relationship of a supplier to a subcontractor is remote. Certificates of Title need to be carefully reviewed by the CEI Consultant.

4) North Water Street and Hamilton Avenue bridges were similar structures and the Contractor submitted a RFC to install a 1" Abutment Anchor at Hamilton Avenue instead of the 1-1/4" anchor that was called for. The material substitution was rejected and the Contractor was officially notified in writing.

   Later in the project, payment to the Contractor was withheld because his testing information showed that 1" anchors were tested, and these did not match the required size.

It was ultimately determined that the Contractor went ahead and installed the 1" Abutment Anchor. The Designer and the DOT reviewed the installation logs and determined that they did not meet the design standards, but would be permitted to remain in place. The Contractor was required to meet the contract size requirement standard on all subsequent stages.

It is recommended that material substitution requests, including those ultimately denied, be distributed to and reviewed by the field inspection staff. As the materials in question are supplied the inspectors need to verify that the Contractor did not unilaterally institute the change he originally requested.

5) Pedestrian Bridge – Design Matters

a. If rooms are to be built and utilized under any structures [in this case stairs] these rooms must be waterproof [no leaks]. The designer's should provide for a rubberized mat or waterproofing system installed prior to concrete placement. In addition, edges and openings should have a recessed seal to insure a waterproof joint/edge.

b. The monolithic deck poured on this particular steel structure would have benefited greatly from expansion joints. Concrete and steel when expanding or contracting at different rates would not have caused as many stress cracks in the concrete deck.

c. If building does not have leaders or gutters, the designer should make sure the roof run off is not discharged over windows louver vents. Brick is porous, and it is advisable to install gutters above non-pedestrian areas as well as pedestrian areas to help keep the building interior dry.

d. When new structures are constructed with a roof above pedestrian occupied areas (in this case a train platform), it is best to insure the roof leaders are either extended down through the deck slab or run off on a sloped grade away from structure.