Connecticut DOT & Industry Design-Build Workshop

PROJECT QUALITY ASSURANCE

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Module Overview

1) QA Terminology and Responsibilities
   (States and Industry not aware of current terms & roles)

2) D-B Procurement: QA Requirements in RFP
   (Requirements often Not Clear in RFP and Contract)

3) Design QA: QC vs. Acceptance
   (Recommended practices / Items to consider)

4) Construction QA: FHWA TechBrief (April 2012)
   (23 of 60 RFPs examined, could not determine Acceptance responsibility – TRR 2081)
Part 1

Quality Assurance Terminology and Responsibilities
Quality Assurance Definition

AASHTO R10 & TRB Circular E-C173

Quality Assurance – “(1) All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service; or (2) making sure the quality of a product is what it should be ...

The use of the term QA/QC or QC/QA is discouraged and the term QA should be used”.
Correct Use of the Term “Quality Assurance”

Per AASHTO, ANSI, ASQ, FHWA, NCHRP, TRB:

QC/QA

Quality Control
(Contractor’s responsibility)

Acceptance
(Agency’s responsibility)
Design-Builder’s Responsibility

• Provide **Quality Control (QC):**
  ▪ Design Quality Control System
  ▪ Construction Quality Control System

• Complete Preliminary Design
• Prepare Final Design
• Issue Construction Documents (Plans & Specifications)
• Construct Project
Agency’s Responsibility

• Develop Concept/Preliminary Design (Pre-RFP)
• Establish Design criteria & Construction standards (in RFP and Contract)
• Provide Project Oversight & **Acceptance**:  
  ▪ **Design Acceptance** System  
  ▪ **Construction Acceptance** System  
  ▪ May augment staff with “**Designated Agent**” staff  
    (Consultant under contract to Agency – NOT under D-B)
Discussion - Questions

- QA Terminology
- Design-Builders Responsibility
- Agency Responsibility
Part 2

D-B Procurement: QA Requirements in Request for Proposal (RFP)
RFP

QA Programs for Design-Build

Design QA Program
- Design Builder
- Design QC System
- Agency Design Acceptance System

Construction QA Program
- Design Builder
- Construction QC System
- Agency Construction Acceptance System

[Best Practice]

[23 CFR 637.207(b)]
RFP

Example Lead QC Personnel

Design-Builder
Quality Control Administrator

- Registered PE
- Minimum 10 Years Experience
- QA Training Certificate (NETTCP 1-Day Course)

Design-Builder
Design QC Manager

- B.S. in Civil Engineering
- Min. 10 Years Experience
- QA Training Certificate (NETTCP 1-Day Course)

Design-Builder
Construction QC Manager

- B.S. in Civil Engineering
- Construction QA Technologist Certification (NETTCP 3-Day)
D-B Quality Management Plan (QMP)

- Recommended practice to require **single comprehensive** Design-Builder QMP:
  - Documents all QC requirements and procedures (both Design QC & Construction QC)
  - Removes potential “stove-piping” between Design and Construction

- Should be reviewed and accepted by the Agency prior to starting work
RFP
Design Quality Control Plans

• Agency may require QC Plans for complex design activities or features (examples):
  ▪ Cable-Stay Bridge Design Elements
  ▪ Storm Water Siphon System

• Identify Design QC Plan format & contents in RFP

• All QC Plans approved by D-B QC Administrator and accepted by Agency
RFP

Construction Quality Control Plans

• Identify **Major Work Items** requiring QC Plans:
  - Earthwork
  - Bridge Substructure Elements
  - Bridge Superstructure Elements
  - Architectural Elements
  - HMA/PCC Pavement

• Specify standard QC Plan format

• All QC Plans approved by D-B QC Administrator and accepted by Agency
QC for D-B Pilot Project

The DB Entity develops a Comprehensive Quality Management Plan (QMP)

- The QMP contains the QC procedures for all design and construction activities and interactions
- The Department accepts the plan
- The DB Entity implements the plan as written
- The plan is expected to be revised if needed with the concurrence/acceptance of ConnDOT
QC System Objectives

- Ensure all elements of the project work meet or exceed the quality requirements set forth in the RFP and Contract
  - Place the responsibility for achieving design and construction quality on the DB Entity
  - Establish procedures for coordinating and ensuring consistency and quality of work
DB Entity QC Personnel

- **Quality Control Administrator**
  - Responsible for overall management of the QC System

- **Design Quality Control Manager**
  - Responsible for implementation of all Design QC procedures and activities

- **Construction Quality Control Manager**
  - Responsible for implementation of all Construction QC procedures and activities
ConnDOT Responsibilities

- Review and acceptance of the QMP
- Monitor and ensure compliance with the QMP
- Participate in revision of the QMP if necessary
- Perform Design and Construction Acceptance activities
Discussion - Questions

D-B Procurement - RFP:
- D-B Entity QC Requirements
- Agency Acceptance Criteria
Part 3

Design Quality Assurance: Design-Builder QC System & Agency Acceptance System
Design-Builder Design QC System

**Informal QC (by Frontline Design Staff)**
- QC “Self-Check” Activities
- Coordination Activities with Construction

**Formal QC (by Design QC Staff)**
- Inter-discipline Reviews
- Independent Structural Design Checks
- Design Package Review at Key Milestones (e.g., 75%, 100%)
Design QC Structure

Design-Builder Quality Control Administrator

Design QC Team
- Structured QC
  - Formal Checks (Milestones)

Construction QC Team
- Structured QC
  - Inspection & Testing (Random)

Design Manager
- Design Production Staff
  - Frontline QC
    - Self-Checks
    - Coordination

Construction Manager
- Construction Production Staff
  - Frontline QC
    - Self-Inspection
Quality Management Plan (QMP)

• Documents all QC requirements and procedures (both Design QC & Construction QC)

• Recommended Sections:
  1. Introduction
  2. QC Organization & Roles
  3. Document Management Procedures
  4. Design QC Procedures
  5. Construction QC Procedures
Agency Design Acceptance System

In-Progress **Acceptance Activity** (by Agency & FHWA Staff)
- “Over-the-Shoulder” In-Progress Design Reviews / Audits

**Formal Acceptance** (by Agency & FHWA Staff)
- Structure Type/Size/Location
- Design Packages - Formal Milestone Review & Acceptance
  (e.g., 75% Design, 100% Plans & Specs, Release for Const. Packages)
Recommended Design Acceptance Staff

- Consultant
  - Prelim. Design
  - Tech. Assistance
- Agency Project Manager
- (District) Design Project Engineer
- (District) Construction Resident Engineer
- FHWA Area Engineer or Major Project Engineer
Design Quality Process

- Quality Management Plan (QMP)
  - Discipline Checklists
  - Designer QC process – checker, back checker
  - Inter-discipline review / Constructability review
  - Independent structural design check
  - Design QC Team (formal QC process)
  - Independent design input verification
  - Agency / 3rd party review
  - Comment Resolution
Design Quality Process

- Quality Management Plan (QMP)
  - Interim review (40-60%)
  - Final review (100%)
  - Released For Construction (RFC)
  - Notice of Design Change (NDC)
  - Field Design Change (FDC)
  - Request For Information (RFI)
  - Request For Information – Owner (RFIO)
  - As-built Record Plans
ConnDOT
Design Responsibilities

- Monitor DB Entity QC activity
- Design Acceptance actions
Discussion - Questions

Design Quality Assurance:
- Design-Builder QC System
- Agency Acceptance System
- Design Quality Issues
Part 4

Construction Quality Assurance:
FHWA TechBrief (April 2012)
Construction QA TechBrief (April 2012)

- **Quality Assurance (QA):** *(NOT specific role of one entity)*
- **Design-Builder Quality Control (QC)**
- **Agency Acceptance**
- **Agency Independent Assurance (IA)**
Construction QA Program Core Elements

- Independent Assurance (IA)
- Dispute Resolution
- Laboratory Accreditation and Qualification
- Personnel Qualification/Certification

Contractor Quality Control (QC)

Agency Acceptance
Design-Builder Construction QC System

**Informal QC** (by Frontline “Production” Staff)
- QC “Self-Inspection” Activities

**Formal QC** (by Construction QC Staff)
- QC of Project Produced Items
- QC of Fabricated Structural Items
- QC of Standard Manufactured Items
- Accredited/Qualified QC Laboratories
- Qualified/Certified QC Personnel
Construction QC Organization

- **Design-Builder Quality Control Administrator**
- **Design QC Team**
  - Structured QC
    - Formal Checks (Milestones)
- **Construction QC Team**
  - Structured QC
    - Inspection & Testing (Random)
- **Design Manager**
  - Design Production Staff
    - Frontline QC
      - Self-Checks
      - Coordination
- **Construction Manager**
  - Construction Production Staff
    - Frontline QC
      - Self-Inspection
**Quality Management Plan (QMP)**

- Documents all QC requirements and procedures (both **Design QC** & **Construction QC**)

- Recommended Sections:
  1. Introduction
  2. QC Organization & Roles
  3. Document Management Procedures
  4. Design QC Procedures
  5. Construction QC Procedures
QMP
5.0 – Construction QC Procedures

• Project Produced Materials
  – QC Inspection Schedules (Attributes, Lot/Sublot Sizes)
  – QC Testing Schedules (Quality Characteristics, Lot/Sublot Sizes)
  – QC Documentation & Data Analysis

• Fabricated Structural Materials
  – Fabricator QSMs (Fabricator QC Inspection & Testing)
  – Project Site QC (Inspection & Testing Schedules)

• Standard Manufactured Materials
  – Manufacturer QSMs - AASHTO R38 (QC Inspection & Testing)
  – Project Site QC (Review of Manufacturer COCs)
  – QC Inspection (at Delivery, during Storage & Installation)
QMP

5.0 – Construction QC Procedures

Construction QC Plans

• Document project-specific Construction QC requirements for **Major Work Items**:
  - Earthwork
  - HMA/PCC Pavement
  - Drilled Shafts
  - Bridge Superstructure
  - Architectural Elements
Agency Construction Acceptance

• All acceptance activities must be carried out by the **Agency** or their **“Designated Agent”**

• Agency **independently** performs:
  - Acceptance Inspection
  - Acceptance (Verification) Testing

• Agency personnel Monitor/Audit Design-Builder QC activities:
  - Verify compliance with Quality Mgmt. Plan and QC Plans
Example Agency Acceptance Staff

- Consultant
  - Prelim. Design
  - Tech. Assistance

- Agency Project Manager

- (District) Design Project Engineer

- (District) Construction Resident Engineer

- FHWA Area Engineer or Major Project Engineer
Attributes to be inspected which reflect quality of finished product [637.207(a)(1)(i)(C)]

- Attributes for:
  - D-B Quality Control
  - Agency Acceptance
### Inspection Attributes - Examples

<table>
<thead>
<tr>
<th>Inspection Component</th>
<th>Quality Control Inspection Attributes</th>
<th>Acceptance Inspection Attributes</th>
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<tbody>
<tr>
<td><strong>Equipment</strong></td>
<td>Mixer Drum Blade Condition</td>
<td>N/A</td>
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<tr>
<td></td>
<td>Vibrator Frequency</td>
<td>N/A</td>
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<tr>
<td></td>
<td>Finishing Machine Settings</td>
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<tr>
<td><strong>Environmental Conditions</strong></td>
<td>Form Cleanliness</td>
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<tr>
<td></td>
<td>Temperature of Air &amp; Contact Surfaces</td>
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<tr>
<td><strong>Materials</strong></td>
<td>Aggregates &amp; Cementitious Material (Correct Type)</td>
<td>Aggregates &amp; Cementitious Material (Correct Type)</td>
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<td>Admixtures (Correct Type &amp; Dosage)</td>
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<tr>
<td></td>
<td>Epoxy Reinforcement Bar (Correct Type / Damage to Coating)</td>
<td>Epoxy Reinforcement Bar (Correct Type / Damage to Coating)</td>
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<td><strong>Workmanship</strong></td>
<td>Form Dimensions</td>
<td>Form Dimensions</td>
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<td></td>
<td>Reinforcement Bar Layout</td>
<td>Reinforcement Bar Layout</td>
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<td>Finished Dimensions</td>
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<td></td>
<td>Surface Defects (Honeycombing, Cracking)</td>
<td>Surface Defects (Honeycombing, Cracking)</td>
</tr>
</tbody>
</table>
Testing Approaches for Acceptance

Two general approaches:

A. Use **Agency Acceptance** (Verification) test data only for the acceptance determination

B. Include Validated **Contractor QC** test data in the acceptance determination
Testing Frequency

• Design-Builder Quality Control
  ▪ Test each Sublot per Lot

• Agency Acceptance (Verification)

  Approach A (Agency data only):
  ▪ Test each Sublot per Lot

  Approach B (Agency data + Validated QC data):
  ▪ Test only some Sublots per Lot (e.g. 25% - 50%)
  ▪ For very large Projects/Lots, some Agencies have used 10% - 20% frequency
Independent Assurance

- Performed by Agency or Designated Agent personnel who are not directly responsible for project Acceptance sampling and testing or inspection
- Provides periodic independent evaluation of QC and Acceptance personnel and their equipment
- Not used to make a determination of work quality or acceptability
Example DB Project QA Organization

Agency (Project Manager)
- (Project Engineer)
  Design Acceptance
- (Resident Engineer)
  Construction Acceptance

Design-Builder (Project Manager)
- Design Production Team
  Frontline QC
- (Design QC Mgr)
  Design QC Team
  Design Quality Control
- (Const QC Mgr)
  Construction QC Team
  Construction Quality Control

Construction Production Team
  Frontline QC

Agency Independent Assurance

Owner’s Responsibility
Design-Builder’s Responsibility
Construction Quality

- D-B Quality Management Plan
  - Pre-activity Work Plan
  - Quality Task Force Meetings
  - Mimic Safety Program success factors
  - Sub-contractor Quality management
  - Build pride in workmanship

- NOT
  - “It’s good enough.”
  - “We don’t have time for inspection or testing.”
Material Sampling & Testing

- Purpose of Design-Builder QC sampling/testing
  - Ensure production/placement is “in control”
- Consistency of on-site material
- Statistical analysis of test data – risk of failure
- Concrete strength – 7 day vs. 28 day results
- Qualified Product List – or Approved Equal
- Reduced Agency sampling & testing rate?
  - (Typical 25-50% - Very large quantities may see 10-20%)
Inspection of Workmanship

- Who should be inspecting work?
  - Foreman – completing standard checklist
  - QC Team Inspector – Daily Inspection Report
  - Agency managed CEI – or Agency staff
- Quality Check Point – Pass or Fail
- How much ‘Inspection’ is needed?
- Collect DATA to build confidence
Construction Quality Wrap-Up

- Partnering between Agency and Design-Builder is the biggest boost to Quality
- Everyone has a role to play – understand your role and don’t duplicate
ConnDOT Construction Responsibilities

- Construction Acceptance actions
  - Monitor DB Entity QC activity
  - Inspection
  - Testing

- Independent Assurance (IA)
  - By ConnDOT Division of Material Testing

- Dispute Resolution system
Discussion - Questions

Construction Quality Assurance:
- Design-Builder QC System
- Agency Acceptance System
- Agency Independent Assurance
- Construction Quality Issues
Summary
ConnDOT Pilot Approach

- Promote DB Entity QC Procedures
- Provide sufficient data to ensure quality
- Review success and failures to improve future projects
Thank You