STRUCTURAL FABRICATION QUALITY MANUAL

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In accordance with the 2012 Standard Specifications for Construction

MDOT
Michigan Department of Transportation

STRUCTURAL FABRICATION UNIT
BUREAU OF BRIDGES AND STRUCTURES

Table of Contents

1 General Information 4

1.1 Definitions 4

1.1.1 Contractor 4
1.1.2 Consultant 4
1.1.3 Design Project Manager (PM) 4
1.1.4 Engineer 4
1.1.5 Engineer of Record (EOR) 4
1.1.6 Fabricator 4
1.1.7 Fabrication Inspection 5
1.1.8 Fabrication Inspection Acceptance 5
1.1.9 Field Inspection Acceptance 5
1.1.10 Materials Quality Assurance Procedures Manual (MQAP) 5
1.1.11 Michigan Department of Transportation (MDOT) 5
1.1.12 Nonconformance Report (NCR) 5
1.1.13 Precast Concrete 5
1.1.14 Procedure Qualification Record (PQR) 5
1.1.15 Quality Assurance (QA) 6
1.1.16 Quality Assurance Inspector (QAI) 6
1.1.17 Quality Control (QC) 6
1.1.18 Quality Control Inspector (QCI) 6
1.1.19 Quality Control Plan (QCP) 6
1.1.20 Request for Information (RFI) 6
1.1.21 Supplier 6
1.1.22 Spot Inspection 6
1.1.23 Structural Fabrication Unit (SFU) 7
1.1.24 Welding Procedure Specification (WPS) 7

1.2 Contact Information 7

1.3 Responsibilities 7

1.3.1 Fabricator 7
1.3.2 MDOT 8
1.3.3 Prefabrication Meetings 9

1.4 QAI Roles and Responsibilities 9

1.4.1 Qualifications of the QAI 9
1.4.2 Equipment Requirements of the QAI 9
1.4.3 Scheduling 9
1.4.4 Role of the QAI 9
1.4.5 Responsibilities of the QAI 10
1.4.6 Interaction with the Fabricator QCI 10
1.4.7 Interaction with Fabricator 10
1.4.8 Interpretation of the Contract 10
1.4.9 Fabrication Observation 10
1.4.10 Nonconforming Materials and Workmanship 10
1.4.11 Final Acceptance of the Work 10

1.5 Narrative Report Writing 11

1.5.1 Expectations for Consistency and Quality of Reports 11
1.5.2 Narrative Reporting Basics 11
1.5.3 Types of Information 12
1.5.4 Acceptable Report Forms 13
1.5.5 Recommended Best Practices for Reporting 15

1.6 Frequently Asked Questions 15

1.6.1 Fabricating without Approved Shop Drawings 15
1.6.2 Inspecting Approved Repair Plans 16
1.6.3 Stamping Pieces Approved for Use 16

1.6.4 Welder Qualification Testing 16
1.6.5 As-Built Shop Drawings 16

2 Fabrication Inspection Procedures 17

2.1 Non-Prestressed Structural Precast Concrete Fabrication 17

2.1.1 Scope 17
2.1.2 Reference Documents 17
2.1.3 Qualifications, Responsibilities, Duties, and Equipment 18
2.1.4 Inspection Procedure 20
2.1.5 Reports 23
2.1.6 Stockpile Payment 24
2.1.7 Acceptance 24

2.2 Prestressed Structural Precast Concrete Fabrication 26

2.2.1 Scope 26
2.2.2 Reference Documents 26
2.2.3 Qualifications, Responsibilities, Duties, and Equipment 27
2.2.4 Inspection Procedure 29
2.2.5 Reports 34
2.2.6 Stockpile Payment 35
2.2.7 Acceptance 36

2.3 Structural Steel Fabrication 37

2.3.1 Scope 37
2.3.2 Reference Documents 37
2.3.3 Qualifications, Responsibilities, Duties, and Equipment 38
2.3.4 Inspection Procedure 40
2.3.5 Reports 46
2.3.6 Stockpile Payment 46
2.3.7 Acceptance 47

2.4 Lighting, Signal, And Sign Support Structure Fabrication 49

2.4.1 Scope 49
2.4.2 Reference Documents 49
2.4.3 Qualifications, Responsibilities, Duties, and Equipment 50
2.4.4 Inspection Procedure 52
2.4.5 Reports 58
2.4.6 Stockpile Payment 59
2.4.7 Acceptance 59

3 Inspection and Test Plans 61

3.1 Hold Points 61
3.2 Establishing and Adjusting the ITP 61
3.3 Communication Between Fabricator and QAI 61
3.4 Standard ITPs and Inspection Levels 61

4 Supplier Qualification Program 62

4.1 Supplier Qualification Standard for Prestressed Concrete Beams 62
4.2 Reserved for Expansion to Other Products 63

5 Approved Supplier List: Prestressed Concrete Beam 64

Appendix A1: Concrete Narrative Reports 66

Appendix A2: Steel Narrative Reports 70

Appendix A3: SQS for Prestressed Concrete Beams 74

Appendix A4: Suggested Radiographic Testing Procedure (non-mandatory) 125

1 General Information

The purpose of the Structural Fabrication Quality Manual (SFQM) is to provide the Michigan Department of Transportation (MDOT) Structural Fabrication Unit (SFU) with information for the implementation of the Department's quality assurance program for fabricated materials required to be accepted based on "Fabrication Inspection" per the Material Acceptance Requirements Table located in MDOT's Materials Quality Assurance Procedures (MQAP) Manual. This manual is instrumental to ensuring consistency in performing quality assurance (QA) fabrication inspection at nationwide and international fabrication plants by providing general information and fabrication inspection procedures. Additionally, this manual includes inspection and test plans (ITP), supplier qualification programs, and approved supplier lists (ASL) for select products. It is important to note that the Department utilizes vendors to provide fabrication inspection and engineering, which are managed by the SFU. Finally, this document is contractual by reference in the MDOT MQAP manual.

1.1 Definitions

Below is a list of terms that are significant to this manual:

1.1.1 Contractor

The Contractor is responsible for proper completion of all tasks required by the contract. Subcontractors, including fabricators, erectors, and field painters, may be used by the Contractor, but the Contractor retains responsibility for all material, operations, and the final product. The Contractor should permit direct subcontractor interaction with MDOT to expedite the project, but subcontractors must inform the Contractor of any proposed modifications to contract requirements.

1.1.2 Consultant

An agency providing services to a client. In Sections 1 through 5 of this SFQM, the term "Consultant" is used to identify the agency performing fabrication inspection services to the MDOT SFU.

1.1.3 Design Project Manager (PM)

The Design PM can be the Engineer of Record or could be managing a consultant contract where the consultant is the Engineer of Record.

1.1.4 Engineer

The Engineer can be the Director of the Department of Transportation or the MDOT Construction Engineer designated by the Director, acting directly or through authorized representatives, who is responsible for engineering supervision of the construction. The Engineer has the authority to allow exceptions to contract document requirements.

1.1.5 Engineer of Record (EOR)

Those preparing the contract documents, including those responsible for the structure's adequate design. The Engineer of Record seals and signs the contract plans.

1.1.6 Fabricator

The facility performing such shop activities as cutting, welding, drilling, punching, tying rebar, tensioning strand, pouring concrete, cleaning, and painting of structural steel, etc. The Fabricator

also includes any agents of the Fabricator, such as those who prepare shop detail drawings, perform nondestructive examinations, paint, etc.

1.1.7 Fabrication Inspection

The examination by MDOT or the Fabricator of processes and products to verify general conformance with contract requirements.

1.1.8 Fabrication Inspection Acceptance

The first step in MDOT's two-part acceptance process for structural products required to be accepted based on "Fabrication Inspection" per MDOT's MQAP Manual.

1.1.9 Field Inspection Acceptance

The second step in MDOT's two-part acceptance process for structural products required to be accepted based on "Fabrication Inspection" per MDOT's MQAP Manual.

1.1.10 Materials Quality Assurance Procedures Manual (MQAP)

The formal written document prepared by MDOT that describes the policies and procedures used to accept materials for incorporation into MDOT projects. The document contains inspection procedures for fabricated structural precast (prestressed and non-prestressed) concrete, structural steel, and other structural products.

1.1.11 Michigan Department of Transportation (MDOT)

The entity (owner) paying the Contractor to fulfill the terms of the contract. MDOT also encompasses the Engineer who is authorized and responsible for engineering supervision of the construction. The Engineer is an employee of MDOT; however, MDOT may contract with a professional firm to oversee the day to day supervision with all critical decisions coming through the Engineer.

1.1.12 Nonconformance Report (NCR)

An alteration in the work or a fabrication error that results in the element not meeting project specifications. The fabricator generates an NCR submittal after fabrication has begun and their QCI has noted a nonconformance to the project specifications.

Nonconformances are generally defined to be material or workmanship in nature and are further classified by MDOT to be minor or major. Minor nonconformances can be repaired by the fabricator without approval of an NCR, whereas major nonconformances require approval of an NCR.

1.1.13 Precast Concrete

Precast concrete is a construction product produced by casting concrete in a reusable form, which is then cured in a somewhat controlled environment, transported to the construction site, and lifted into place. Precast concrete can be either prestressed or non-prestressed. In contrast, cast-in-place (CIP) concrete is poured into site-specific forms and cured on site.

1.1.14 Procedure Qualification Record (PQR)

A production welding procedure specification qualification is based on a procedure qualification test record (PQR) produced by the Contractor in conformance with required heat input qualifications and other code requirements. The test is designed to provide assurance that the

weld metal produced by welding in conformance with the provisions of the code must produce weld metal strength, ductility, and toughness conforming to the code.

1.1.15 Quality Assurance (QA)

Quality assurance (QA) encompasses the activities undertaken by the Owner to verify that the final product satisfies contract requirements, including verifying that quality control is performed effectively.

1.1.16 Quality Assurance Inspector (QAI)

MDOT's representative that is responsible for duties specified in the MDOT MQAP, with the authority to accept work that meets contract requirements.

1.1.17 Quality Control (QC)

The activities undertaken by the Contractor/Fabricator to ensure a product meets contract requirements.

1.1.18 Quality Control Inspector (QCI)

A qualified employee of the Fabricator who performs inspection as defined by the Fabricator's Quality Control Plan.

1.1.19 Quality Control Plan (QCP)

The QCP is a document developed by the Fabricator describing, in detail, all aspects of production and fabrication for the project to ensure consistent control of quality to meet specification requirements.

The Quality System Manual (or Quality Manual) prepared by the Fabricator and reviewed by a certification body (ACPA, AISC, NPCA, PCI, etc.) may satisfy the requirements of a QCP.

These documents may not include enough detail to function as a QCP for MDOT projects. Fabricators may need to supplement their manuals with separate plans and procedures that address MDOT project-specific requirements. This approach limits the need for rewriting and resubmitting their manuals for certifying body approval.

1.1.20 Request for Information (RFI)

Requests by the Fabricator seeking additional information or proposing alternate material, fabrication method, or inspection method for the structural element.

1.1.21 Supplier

The firm (fabricator, manufacturer, galvanizer, producer, etc.) selected by the Contractor and approved when required by MDOT to provide products and services to MDOT for a specific project.

1.1.22 Spot Inspection

The random examination of the Fabricator's processes or products for verification of conformance with contract requirements.

1.1.23 Structural Fabrication Unit (SFU)

MDOT's specialized construction unit that is responsible for implementing the Department's QA program for fabricated materials required to be accepted based on "Fabrication Inspection" per MDOT's MQAP.

1.1.24 Welding Procedure Specification (WPS)

A formal written document specifying a welding procedure, which provides direction to the welder or welding operators for making sound and quality production welds in accordance with the American Welding Society (AWS) code requirements. The WPS is supported by a PQR or is based on a prequalified joint and results in repeatable and trusted welding techniques.

1.2 Contact Information

For all instances where this document states for the QAI to notify, carbon copy, or contact the SFU, the communication must be directed to the consultant's PM. The consultant's PM will in return notify, carbon copy, or contact the SFU as required. Please see the SFU contact information below:

- Concrete Projects: MDOT's Structural Precast Concrete Specialist
- Steel Projects: MDOT's Structural Steel Specialist
- Engineering: MDOT Structural Fabrication Engineer

1.3 Responsibilities

Below are expectations for a team effort and responsibilities to help ensure success.

Team Effort

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction.

All parties will cooperate and maintain open lines of communication so that problems can be quickly addressed and resolved.

The QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection and produce a product satisfying the contract.

1.3.1 Fabricator

a. Provide quality control to ensure that the finished product meets or exceeds contract requirements.

b. Develop and implement a QCP that reflects a commitment to quality and describes the quality control activities that will be employed on each project.

c. Provide MDOT with a copy of the QCP.

d. Submit shop drawings to MDOT for review with WPS and supporting PQR, as applicable.

e. Provide a Material Source List (MSL) for structural precast (prestressed and non-prestressed) concrete projects prior to the prefabrication meeting.

f. Provide qualified QCIs who report to personnel responsible for quality control as defined by the QCP.

g. Provide MDOT with an accurate notification before beginning work in the shop and all production scheduling as required by the contract requirements.

h. Present all material for the QAI 's acceptance in a manner that will allow a thorough inspection of components and assemblies.

i. Provide the QAI full access to shop facilities where the work is being stored, fabricated, or assembled.

j. Provide the QAI with all approved shop drawings, NCRs, RFIs, MDOT Welder Qualification test reports, WPSs, QC reports, material certifications/test reports, non-destructive examination/non-destructive test (NDE/NDT) reports, personnel/plant certifications, equipment calibration reports, and all other applicable documents in a timely manner as required by the contract requirements.

k. Keep the QAI informed prior to performing in-process repairs, NCRs (if applicable), QC inspection activities, and pending NDE/NDT (if applicable).

1.3.2 MDOT

The items below which identify MDOT as the subject are included to clarify MDOT policies affecting quality assurance. All other items are responsibilities of both MDOT and the QAI.

a. Monitor the Fabricator's control of the operations and verify conformity of the work with the contract requirements.

b. Keep the Fabricator's QCP confidential.

c. Observe fabrication (either on a schedule or at random) and perform testing of materials and fabricated products as necessary to confirm the effectiveness of the Fabricator's QCP.

d. MDOT, either directly or through the QAI, has the right to observe all phases of the work, from initial receipt and preparation of raw materials through prestressing, tying steel, fresh concrete testing, placing concrete, testing cylinders, repairs, burning and cutting, welding, nondestructive testing, cleaning, coating, shipping, and any other activities deemed appropriate by MDOT.

e. The frequency and nature of QA inspection will vary with the type of structure, experience of the Fabricator, strength of the Fabricator's QC organization, and other similar factors that affect the quality of work.

f. Verify that production quality and fabrication processes generally satisfy contract requirements, including the QCP.

g. Accept materials and fabricated products that satisfy the contract requirements.

h. Notify MDOT when fabricator ships products for projects and specify if the shipment is the final shipment for the project.

i. Submit project file to MDOT within one week of final shipment of products.

j. MDOT will not waive items that are contractual obligations of the Fabricator and will not accept material that does not conform to the contract requirements. However, based on experience and knowledge of the specific situation, the Engineer may accept materials and products that are not in conformance with the contract and may allow material substitutions and/or alternate fabrication methods. See the following documents for more information:

   - MDOT Structural Fabrication RFI Process
   - MDOT Structural Fabrication Nonconformance Policy

k. Avoid directing the Fabricator's work but advise the Fabricator to discontinue any operation that would result in noncompliance with the contract.

l. Direct all official communications to the Fabricator's quality control or management as determined in the prefabrication meeting.

m. Avoid conveying directives or personal judgements about overall shop quality or concerns about employee competence to production personnel.

n. Neither MDOT nor the consultant will publish, copy, or distribute any proprietary information, documents, or forms received from the Fabricator for any purpose other than the contractual needs of MDOT.

1.3.3 Prefabrication Meetings

Prefabrication meetings facilitate effective quality control and quality assurance and are conducted by the SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must be present, whereas the Engineer and Contractor should be present to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective and timely communication.

1.4 QAI Roles and Responsibilities

1.4.1 Qualifications of the QAI

Qualification requirements of the QAI is covered in Chapter 2 of this manual for the required fabrication inspection procedure.

1.4.2 Equipment Requirements of the QAI

Equipment requirements of the QAI is covered in in Chapter 2 of this manual for the required fabrication inspection procedure.

1.4.3 Scheduling

The scheduling of inspection and other QA functions can have a significant impact on the project. The QAI must follow these guidelines:

a. Coordinate with the QCI for anticipated production scheduling to anticipate timing and staffing needs. Discuss the progress of the work with appropriate fabrication personnel designated during the prefabrication meeting.

b. Schedule inspections in a timely manner to facilitate fabrication progress, especially if multiple shifts are used.

c. Discuss with the SFU whether additional presence in the shop is required.

d. Document problems with scheduling inspection, including inaccurate information from fabrication personnel and production delays.

1.4.4 Role of the QAI

a. Perform verification tests, measurements, inspection, or observations to ensure that fabricated products conform to the contract requirements. Although the QAI does not perform the QC work, some QA activities may duplicate a portion of the QC activity for verification purposes.

b. If there are questions about a requirement or level of quality, contact the SFU and, if appropriate, alert the Fabricator.

c. Conduct consistent inspections based on the fabrication inspection procedure and ITP and obtain assistance from the SFU as needed.

d. Be familiar with the QCP to better understand the QC operations of the shop.

1.4.5 Responsibilities of the QAI

The QAI is generally responsible for executing MDOT's responsibilities which are listed above in subsection 1.3.2. Product specific responsibilities are further detailed in the Fabrication Inspection Procedures below.

1.4.6 Interaction with the Fabricator QCI

a. Verify the effectiveness of the QCI's evaluation of the work.

b. Perform verification inspection after the QCI has completed their inspection and testing in accordance with the Fabricator's QCP. However, serious problems noted at any time or stage of fabrication must be immediately pointed out to the QCI.

c. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

1.4.7 Interaction with Fabricator

If the Fabricator's inquiries involve design questions, material substitutions, alternate fabrication methods, or items that are beyond the authority of the QAI, please refer them to *MDOT's Structural Fabrication Request for Information Process*. If the Fabricator's inquiries involve fabrication or material nonconformance questions, please refer them to *MDOT's Structural Fabrication Nonconformance Reporting Process*. Do not direct the fabricator.

1.4.8 Interpretation of the Contract

Review contract requirements and seek guidance from the consultant's PM if there are questions. Do not direct the Fabricator.

1.4.9 Fabrication Observation

1. Establish a pattern of regular and frequent observations during the progress of work to verify satisfactory workmanship without delaying production or missing critical operations.

2. Coordinate verifications with the QCI and accomplish them with minimal additional material handling by the Fabricator and with as little interference with the work in process as possible.

3. Though there are not designated points during fabrication when the suitability of materials must be checked, problems should be discovered and addressed as early as possible.

4. Provide narrative records in accordance with subsection 1.5 of this manual.

1.4.10 Nonconforming Materials and Workmanship

See MDOT's Structural Fabrication Nonconformance Policy and MDOT's Structural Fabrication Nonconformance Reporting Process for more information.

1.4.11 Final Acceptance of the Work

Acceptance of structural products must be in accordance with Chapter 2 of this manual and the Inspection and Test Plan specified in the MDOT work assignment.

1.5 Narrative Report Writing

The purpose of this section is to provide MDOT's QAIs guidance on preparation of the narrative report that is submitted to MDOT's Structural Fabrication Unit. This guidance will be used to ensure consistent presentation of the required information and format. While the examples are focused on steel and concrete fabrication, this guidance applies to all materials and products requiring fabrication inspection as the basis of inspection

This section is broken down into the following subsections:

1. Expectations for Consistency and Quality of Reports
2. Narrative Reporting Basics
3. Types of Information
4. Acceptable Report Forms
5. Recommended Best Practices

1.5.1 Expectations for Consistency and Quality of Reports

MDOT expects its QAIs to strive for consistent and high standard of reporting, both from a single inspector and across all QAIs. This can be achieved in part by adhering to general writing requirements and making accurate and detailed accounts of observations.

1.5.2 Narrative Reporting Basics

Narrative reports require discipline and skill. Good habits and time management are necessary QAI practices to ensure observations are captured while the details are fresh. Obscure writing styles can lead to misinterpretation of information. Unbiased and emotionless writing is essential for the level of professionalism expected by MDOT.

1.5.2.1 Frequency

The narrative report is a weekly documented summary of the daily activities that the QAI has witnessed being conducted by the Fabricator or has performed as part of their assigned duties. Complete the report as close to the end of shift as possible while events are still fresh in the QAI's mind.

1.5.2.2 Style

When preparing the narrative report, be clear and concise. Use complete sentences to describe the observations and tasks performed. Extended or detailed explanations are discouraged unless there is a need to convey additional information that may not be recorded on other MDOT reporting forms.

Spell out the first-time use of abbreviations or acronyms not already defined in contract documents or industry standards. Avoid using industry slang.

Use of tables, lists, or other presentation methods is encouraged.

Use space between sections and new paragraphs for each process or activity. Use underlining or bold fonts or other positive means of starting new days.

Insert photographs when applicable for supporting descriptions of quality issues or nonconformity. Make sure photographs are date/time stamped and labeled for easy reference.

1.5.2.3 Perspective

Eliminate any bias or insensitivity. Emotion or personal feelings of the QAI regarding the observations encountered in the fabrication shop is inappropriate. Treat the narrative report as a permanent professional record that may be read by many different audiences.

1.5.3 Types of Information

Although MDOT does not expect an inordinate amount of time spent on report writing, narrative reports must be accurate and provide a thorough report of observations. The QAI's account must include fabrication progress, QAI observations, overall project status, and important discussions.

1.5.3.1 Fabrication Progress

Provide a discussion of the progress of fabrication observed in the shop over the reporting period. Address all the aspects of the work occurring in the shop. Keep the discussion brief in nature. Indicate whether the work was observed by the QAI in progress or was completed without QAI presence. The entries in the narrative report may be made daily if the progression of work is very rapid and changing daily. Alternatively, a weekly summary of work may be made if the progression of work is relatively slow for larger and complex projects.

1.5.3.2 QAI Observations

Record the QAI observations made to determine fabricator compliance to established written procedures and contract specifications. Examples of these observations include verifying the welding machine set-up matches the established weld procedure or observing aggregates for signs of contamination, segregation, or gradation concerns; note the QAI's direct measurements when performing verification testing or inspection. Include issues with ineffective QC performance. Clearly indicate which procedures and contract specification requirements were verified and the day(s) that the compliance was observed.

1.5.3.3 Project Status

Document the status of the project. Indicate the estimated percent complete. A best guess of the percentage complete is appropriate especially when the project complexity obscures the determination; percentage can be based on number of pieces or weight or another reasonable characteristic.

1.5.3.4 Important Discussions

Document important discussions held during the week in the Narrative Report. Important discussions include schedule and inspection coordination, project team communications, interaction with QC on complex issues such as nonconformance resolution or notification of observed deficiencies. Information required for each discussion includes:

1. Purpose of the discussion
2. Date and time the discussion
3. Type of discussion (face-to-face, telephone, video, etc.)
4. Duration
5. Attendees
6. Outcomes of the discussion (decisions made, recommendations provided, action items

assigned, etc.)

1.5.4 Acceptable Report Forms

MDOT will accept narrative reports on either its preferred Form 5617 or the consultant's preferred form, provided they adhere to standard content requirements.

1.5.4.1 MDOT Forms

MDOT provides Narrative Report form 5617 in a fillable PDF file for use by the QAI.

1.5.4.2 Consultant Forms – Specific Required Fields

The QAI consultant may choose to use their own form using a platform that best suits their needs. The minimum following fields must be included in the consultant's form:

1. The Inspection Agency
2. The Inspector
3. Date / Week Ending
4. Job Number
5. Control Section
6. Job Description
7. Report Number
8. Material being fabricated
9. Section for Daily Narrative/Comments
10. Fabrication Progress (% complete)
11. Visual Inspection (VI)
12. Material Acceptance

1.5.4.3 Specific Information Required – Both Forms

Narrative Reports, whether written on MDOT Forms or Consultant Forms, are written by the QAI for several types of products supplied to MDOT. These products categories are described earlier. Supplemental to the minimum required fields explained above and the general report contents discussed below, MDOT also expects inclusion of information specific to each type of material (concrete or steel); this supplemental information is detailed in Appendix 1 and 2 below.

Narrative sections of any report must include the following general contents:

✓ **Brief Narrative of Work Performed:**

Briefly highlight the work performed by the QAI for each day they were present at the fabricator and actively working on MDOT projects.

✓ **Weather Conditions:**

It is important to document the weather conditions that were experienced for the given day. Temperature, precipitation, wind conditions, and relative humidity can play a significant role in the outcomes of a fabricated product. Although some Fabricators conduct their operations inside of protected buildings, record outside weather conditions every day. Include the average conditions and extreme changes such as wind, rain, or snow events. Indicate the exposure level of the work

(i.e. – completely controlled enclosure, partially enclosed without control, completely exposed to weather)

- ✓ **Elements Worked on by the Fabricator:**

Identify what piece marks or elements were worked on during the reporting period.

- ✓ **Materials Incorporated into the Elements:**

Provide a list of materials that are being incorporated into the elements being produced. This may be documented in the Narrative Report or may be referred to a specific report that is generated by the QAI. For precast concrete elements, including this list on MDOT Form 5617 is enough.

- ✓ **Work Activities:**

Document the work activities that were conducted by the fabricator. Include a current schedule of upcoming work each week and note major changes or deviations by the fabricator.

- ✓ **Requests for QA Inspection and Satisfaction of Hold Points:**

Record requests for QA inspection from the fabricator, notification from the fabricator of reaching hold points, and any hold points that were satisfied or waived. Include details unless the means of communication was written; otherwise reference the written communication by type (email, letter, etc.), sender, and date/time.

- ✓ **Nonconformances:**

Document nonconformances issued by the QAI in the Narrative Report. If a Nonconformance Report has been generated by the fabricator, note this in the report as well as the nature of the nonconformance. Reference the Nonconformance Report number when documenting the resolutions to the nonconformance including witnessing of the repairs and reinspections. Include the notification to QC.

- ✓ **Shipping:**

Provide the status of the shipping of elements as the information becomes available. This would include indicating that pieces have been inspected, reported on the appropriate MDOT form and stamped for shipping, the bill of lading has been reviewed and stamped, and scheduled dates for shipping current stamped piece marks/elements and future piece marks/elements.

- ✓ **Hours Worked:**

Document the hours worked during the reporting week. Report hours to the required accuracy, typically in half-hour increments. These hours include:

1. Total hours at the shop
2. Hours on the shop floor
3. Hours worked on MDOT projects
4. Hours worked on report and form preparation
5. Travel time

- ✓ **Force Account Work:**

There may be rare occasions where the fabricator may be supplying product under a force account. Document the dates and elements that were worked on in the Narrative Report as Force Account Work and ensure that documentation required for MDOT Form 1101A is referenced in the report.

✓ **Other Information the QAI Deems Important:**

Report information that is deemed important to the production, inspection, delivery, and schedule of the project. Note any concerning practices or controls.

1.5.5 Recommended Best Practices for Reporting

These additional guidelines explain MDOT's expectations for professional reports based on observed best practices among its consultants and report sampling from other agencies outside MDOT.

✓ **Referencing External Records/Reports**

Provide direct references to other required MDOT forms or supporting QA reports/records. This includes tying specific processes conducted by the QAI or the fabricator to the required MDOT form/record. For example, if the QAI witnessed a certain procedure that required reporting on a specific form, the QAI would note the observation and refer to the specific form for the results/observations. A list of completed forms by report number for that day is also acceptable.

✓ **Identifying Verified Materials**

Document material verification and acceptance per batch, lot, heat, item, brand, supplier, etc. when provided in the Narrative Report. Ensure that the recorded information is easily understood. In certain circumstances, it may be suitable to report the material in a tabular format.

✓ **Reporting Coordinated QC Activity**

Clearly identify QAI performance of QC activities or process. This may be an activity that is conducted in conjunction with the QC or a standalone activity

✓ **Reporting Untimely Notification**

Provide feedback on QC performance by the fabricator. Note the QC department's involvement in providing timely notification to the QAI regarding inspection hold points. Identify QC process steps that were omitted, or not addressed in an appropriate manner.

✓ **Avoid Running Lists**

Refrain from restating specification, material, or procedure compliance from earlier days or weeks. Avoid copying and pasting data or information, such as tables or lists, from previous days. Only report the activities observed or performed that day. Keep a running list separately for progress tracking, making it available to MDOT upon request.

✓ **Report Your Own Observations**

Never report the observations or comments of other inspectors. Properly qualified temporary replacement or substitute inspectors may assist an assigned shop inspector. The assigned inspector may not report the activities on behalf of the performing inspector. Avoid more than one inspector's name on a single report; each inspector must prepare an independent report, regardless of the crossover of activities.

1.6 Frequently Asked Questions

The purpose of this section is to provide answers to frequently asked questions to ensure consistency and alignment.

1.6.1 Fabricating without Approved Shop Drawings

The QAI's PM must notify the SFU immediately if the Fabricator is working without MDOT approved shop drawings or if each sheet of the shop drawings is not stamped. Approved shop drawings are required prior to stamping products approved for shipping.

1.6.2 Inspecting Approved Repair Plans

QAI must have the approved repair plan in hand prior to performing QA verification inspection of the repair. Verification inspection also includes confirming that production and QCI have the approved repair plan. If production and QCI do not have the approved plan, then the QAI must notify them that they are required to have the approved plan in hand during all aspects of the repair. If the Fabricator begins working on the repair without the approved plan, then the QAI must notify the Fabricator of their observation in writing immediately and carbon copy their PM. The consultant's PM will discuss with the SFU to determine if the repair will be approved or rejected.

1.6.3 Stamping Pieces Approved for Use

QAI must have approved shop drawings prior to stamping any element approved for use. Pieces proposed to be shipped by the Fabricator that are not in general conformance with the approved shop drawings must not be stamped. The only exception is if an NCR has been approved by MDOT. Approved NCRs are to be used in conjunction with approved shop drawings for acceptance. If products are not in conformance with the approved shop drawings, then they are not to be stamped approved for use by the QAI. Approved RFIs must be incorporated into the shop drawings, if applicable, prior to shipping.

1.6.4 Welder Qualification Testing

See MDOT's Welder Qualification Program for all welding information.

1.6.5 As-Built Shop Drawings

The Fabricator is required to submit as-built shop drawings to MDOT for historical purposes. All approved RFIs that are incorporated into the project must be reflected in the shop drawings and submitted to MDOT for review and approval. Very minor changes toward the end of fabrication must be documented and submitted as as-built shop drawings to the QAI prior to shipping. NCRs are not required to be incorporated into shop drawings. The SFU can provide more guidance on a project by project basis as to what constitutes a shop drawing revision and what is considered an as-built.

2 Fabrication Inspection Procedures

2.1 Non-Prestressed Structural Precast Concrete Fabrication

2.1.1 Scope

This non-prestressed structural precast concrete fabrication inspection procedure should be used to aid the QAI in interpreting and enforcing the contract for non-prestressed concrete products. Fabrication inspection includes the time from verifying materials used for fabrication through loading for shipping to the construction site. The following non-prestressed structural precast concrete products are inspected using this procedure:

1. Bridge main members
2. Bridge secondary members
3. Culverts
4. Prefabricated bridge element systems
5. Mechanically stabilized earth panels
6. Noise barrier wall posts and panels
7. Other products as specified in the contract or directed by the Engineer

2.1.2 Reference Documents

A. QAI must have a thorough knowledge of the following references:

1. The applicable sections of the MDOT Standard Specifications for Construction (MDOT SSC) as modified by *Supplemental Specification 12SS-001A Errata*.
2. The following *Frequently Used Special Provisions (FUSP)*, as applicable:

12SP-105A	Source of Steel and Iron (Buy America)
12SP-706D	Mechanically Stabilized Earth Retaining Wall System
12SP-708C	QC and Acceptance of Structural Precast Concrete
12SP-905A	Steel Reinforcement Revisions
12SP-911A	Water

3. *MDOT Structural Precast Concrete QAI Manual*
4. *MDOT Materials Source Guide (MSG)*
5. Prefabrication meeting minutes (if available)

B. QAI must be familiar with the following references:

1. *MDOT Structural Fabrication Request for Information Process*
2. *MDOT Structural Fabrication Nonconformance Process*
3. Michigan Test Methods

MTM 108	Michigan Test Method for Materials Finer than No. 75 Sieve in Mineral Aggregates by Washing

MTM 109	Michigan Test Method for Sieve Analysis of Fine, Dense Graded, Open Graded, and Coarse Aggregates in the Field
MTM 110	Michigan Test Method for Determining Deleterious and Objectionable Particles in Aggregates

4. ASTM Standards

C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 94	Standard Specification for Ready-Mixed Concrete
C 138	Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete
C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
C 172	Standard Practice for Sampling Freshly Mixed Concrete
C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
C1504	Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts and Storm Drains
C1577	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
E 29	Standard Practice for using Significant Digits in Test Data to Determine Conformance with Specifications

5. MDOT Accident Prevention Plan

2.1.3 Qualifications, Responsibilities, Duties, and Equipment

2.1.3.1 Qualifications of the QAI

QAI performing the fabrication inspection must possess the following qualifications:

1. Michigan Concrete Association (MCA) Level I Field Testing Technician certification or American Concrete Institute (ACI) Concrete Field Testing Technician – Grade I (except period of effectiveness will be reduced from 5 years to 3 years to match MCA); and
2. QAI must possess the necessary Michigan Certified Aggregate Technician (MCAT) Level I, Level II, or Aggregate Sampling certification, for performing aggregate testing or sampling respectively. Actual levels of certification required depend on the testing.

2.1.3.2 Responsibilities of the QAI

QAI performing the fabrication inspection is not permitted to make changes to the contract and has the following responsibilities:

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction. QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection to produce a product satisfying the contract. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

QAI is the responsible party, representing the Engineer, who performs quality assurance verification inspection on the element after QC inspects and approves the item of work. The QAI must provide inspection during fabrication as directed by the Engineer and must perform each inspection item shown in subsections 2.1.4.3 thru 2.1.4.7 a minimum of once per project or per the project ITP whichever is more frequent. If issues arise, it will be at the Engineer's discretion whether to increase the level of QA inspection.

It is the Engineer's responsibility to engage the EOR when making structural decisions. The Engineer is also responsible for following internal MDOT procedures for review and approval of shop drawings, fabrication procedures, RFIs, NCRs, and for professional decision making on fabrication problems that arise. The Engineer relies on the SFU to manage and assist when appropriate. The Engineer has the prerogative for holding a prefabrication meeting with the Fabricator to discuss and clarify the contract plans and specifications. The Engineer is the responsible party who ensures MDOT's fabrication QA program is followed for inspection and acceptance of the element.

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the SFU is aware of this activity and await instruction on how to proceed. If the Engineer permits the work to proceed without approved shop drawings, proceed with basic QA functions using the non-approved shop drawings. Later, verify notes against approved drawings. Notify the SFU immediately if fabrication is not in conformance with the approved shop drawings.

2.1.3.3 Duties of the QAI

QAI performing the fabrication inspection has the following duties:

1. QAI must thoroughly understand the contract.
2. QAI must verify steel material certifications show compliance with Buy America contract requirements.
3. QAI must be proficient in performing fresh concrete tests, sampling aggregate and other materials, verifying material traceability, and inspecting concrete pours.
4. QAI must be proficient in writing reports and using computers.
5. QAI must notify the Engineer if production begins before approved shop drawings are on the shop floor and provided to the QAI.
6. QAI must communicate all concerns through QCI or whomever the Fabricator directs during the prefabrication meeting.
7. QAI must communicate with QCI to obtain the work schedule.
8. QAI must follow *MDOT's Structural Fabrication E-Construction Process* for closing out fabrication inspection file.

2.1.3.4 Deficiencies on Local Agency Projects

MDOT's QAI must notify the SFU if they observe fabrication or inspection deficiencies on local agency program (LAP) projects. The Structural Fabrication Engineer will report the deficiencies via

email to the Engineer that is responsible for construction oversight of the local agency project and carbon copy the applicable CFS and Design Division LAP Engineers.

2.1.3.5 Inspection Facilities and Access

Facilities for the QAI must be provided by the Fabricator per contract. QAI must always have access to all parts of the work. The authority and general duties of the QAI are specified in Section 104.01.D and E of the MDOT Standard Specifications for Construction.

2.1.3.6 Inspection Equipment

QAI will be furnished with the following items by the Engineer:

1. Contract (MDOT SSC, special provisions, standard plans, special details, plan sheets, etc.)
2. Approved shop drawings (provided by Fabricator)
3. MDOT shop approval stamp
4. Numbered plastic sample tags, sampled adhesive tags for material sampling, and numbered metallic MDOT sample tags

QAI must provide the following inspection equipment:

1. Computer with high speed internet access
2. Cell phone
3. Digital camera (can be integral with cell phone)
4. Flashlight
5. Temperature measuring devices capable of covering the range from 0°F to 200°F
6. Fresh concrete testing equipment (thermometer, slump cone kit, and air-meter)
7. Measuring devices (200 foot and 20-foot steel tape and calipers)
8. Straightedge and levels
9. Safety equipment
10. Other as needed for the project

2.1.4 Inspection Procedure

2.1.4.1 Prefabrication Meeting

Prefabrication meetings facilitate effective quality control and quality assurance on the project and are conducted by the SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must be present, whereas the Engineer and Contractor should be present to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective communication.

2.1.4.2 Inspection Overview

Non-prestressed concrete must be fabricated in accordance with the MDOT SSC and contract. Fabrication inspection is performed in accordance with the ITP specified in the MDOT work assignment.

1. Non-prestressed concrete fabrication inspection consists of verifying compliance with the approved shop drawings, contract, and approved NCRs. RFIs must be incorporated into the approved shop drawings for the QAI to inspect to.

2. A Materials Source List (MSL), submitted by the Fabricator to the MDOT Structural Fabrication Unit and the Engineer for review and approval, is provided to the QAI. The QAI reviews what materials are being incorporated into the project and documents the basis of acceptance for each material. The MSL is used to track material sampling by the QAI and to foster communication with QC to ensure all required sampling and testing occurs in a timely manner to prevent impacts to the project schedule. It is the Fabricator's responsibility to notify the QAI when materials are available for sampling.

3. QAI begins by inspecting materials that will be used in the fabrication process and ensures they are being stored correctly, tagged for traceability purposes, and are in conformance with the contract. Next, the QAI inspects the Fabricator's operations to ensure the condition of the equipment and work area for conformance to the contract.

4. MDOT's Accident Prevention Plan states, "MDOT employees shall not engage in any act which would endanger another employee or themselves". QAI must notify the Engineer immediately if work conditions exist that are not safe. If the level of inspection diminishes below what is specified in this QA procedure, due to safety concerns, then the element will not be approved for use.

2.1.4.3 Forming and Casting

1. General Information

QAI must confirm the dimensional requirements of the bulkheads, side forms, bearing plates, steel reinforcement, void boxes, inserts, and any other devices per the approved shop drawings as part of their post-pour inspection. The only exception is that anything that cannot be inspected post-pour, must be inspected during pre-pour. It is important to emphasize that QA must not supersede QC so the QAI's inspection must come after QC has completed their inspection and approves the element. QAI then uses the QC inspection reports (if available) during their verification inspection.

2. Concrete Forms

Concrete forms must be maintained and remain true to the shapes and dimensions as shown on the approved drawings.

a. Metal forms must be used since they are designed to be rigid for repetitive castings without deforming or weakening due to the heat from the hydration process. Forms must be well braced and stiffened against undesirable deformations under pressure of fresh concrete and must have smooth joints and inside surfaces accessible for adequate cleaning after each use.

b. Joints between panel forms must be made and maintained smooth and tight. Unless otherwise shown on approved shop drawings, all corners or intersections of surfaces exposed in the completed structure must be chamfered with a minimum dimension of 0.50 inches and all re-entrant angles must be rounded with a minimum radius of 0.75 inches.

c. Forms that are warped, distorted, damaged, or improperly cleaned must not be used. Wood forms may be used for bulkheads. The inside faces of all forms must be coated with an approved chemical release agent.

3. Reinforcing Steel

QAI must confirm that the reinforcing steel is of the correct size, free from defects, and properly positioned. The reinforcing steel must be free of oil, lubricants, foreign material, and excessive rust. If epoxy coated bars are to be used, then nicks in the coating are not permitted.

QAI must spot check that the reinforcing steel has been properly positioned and secured in accordance with the approved shop drawings and make certain that inserts have been placed where required.

4. Tests on Fresh Concrete

QAI must perform testing as required in the contract and document the results in MDOT Form 0590. The Fabricator must collect additional fresh concrete for QAI to perform their tests as needed.

5. Placing of Concrete

The concrete must be promptly placed with minimum handling to avoid segregation of the materials and the displacement of the reinforcement. Each element must be cast in a continuous operation with minimal interruption between the placing of adjacent portions of concrete and each layer must be placed and consolidated before the preceding layer has taken initial set.

6. Consolidation of Concrete

A minimum amount of vibration necessary to thoroughly consolidate the concrete must be used. QAI must verify a rubber coated vibrator head is used when epoxy-coated or other coated reinforcement is used.

2.1.4.4 Curing Requirements

Curing requirements for non-prestressed concrete must be as specified in the contract. When steam or radiant heat curing is used, recording thermometers must be provided by the Fabricator that monitors the time/temperature relationship through the curing period while artificial heat is used. The QAI must verify that the recording thermometers are placed in critical locations for monitoring the time/temperature relationship during the curing period. Recording thermometers (number based on project requirements) must be placed at locations where the anticipated heat generated by the concrete is the lowest and highest just after initial concrete set. Documentation from the Fabricator's recording thermometer must be given to the QAI for their review. Temperature requirements during the curing operation must be in accordance with the contract specifications.

2.1.4.5 Material Requirements

Materials must meet the requirements of the contract unless an RFI requesting alternate materials has been approved by the Engineer.

2.1.4.6 Shipping Requirements

Products must attain the required compressive strength as indicated by test results of QC compressive strength test cylinders, which have been cast and match cured for this purpose as described per the contract. These cylinders must be cast with numbered metallic MDOT sample tags.

2.1.4.7 Concrete Compression Strength Testing

QAI witnesses concrete strength testing at the sampling frequency of the governing ITP. Watch for specimen ID, handling, machine condition, and QC procedural compliance. Verify proper interpretation and reporting of results by the QCI.

2.1.5 Reports

A. The Engineer may require a periodic status report from the SFU; therefore, all reports are required to be completed in a timely and orderly manner using the applicable forms listed below that can be found on MDOT's website. Make entries as soon as possible after an event or conversation to ensure accuracy. Number the reports consecutively until completion of the work with the last report noted "final".

B. QAI must complete an accurate and detailed account of fabrication for the project. The report must include a discussion of fabrication progress for all aspects of the work. It is intended to be a detailed record of the status of fabrication and should include number of products fabricated, documentation of specification and procedure compliance as well as documentation of conflicts, repairs, and other problems or discussion which could affect the project in any way. If force account work is taking place, document each day that the work occurs in the shop and which products are being worked on.

C. Documentation is not a substitute for appropriate dialogue with the Fabricator but should provide a record of important discussions. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the SFU's correspondence.

D. Reports must be assembled into one fabrication inspection portable document format (PDF) file and stored in MDOT's ProjectWise document storage program per *MDOT's SFU's E-Construction Process*. The Engineer will receive a fabrication inspection memorandum from the Structural Fabrication Engineer after fabrication inspection is complete. The memorandum is for informational purposes and is not used for acceptance.

E. Below is a list of various MDOT reports/forms and a brief description of their purpose and use requirement. Similar forms can be used in place of the standard MDOT form if noted below. All completed forms or equivalent forms are placed in the fabrication inspection file at the end of the project.

1. *Project Folder Checklist (Form 2001)* – This form must be completed by QAI for each project. The checklist is placed on top of the fabrication inspection file when the project is complete.

2. *Shop Inspection Report (Form 5617)* – This form (or the consultant's company form) must be completed by QAI on a weekly basis for each project and should contain a brief narrative of the work performed over the reporting period and include photos when necessary while omitting emotions and personal feelings. Refer to the Narrative Report Writing section earlier in this document for requirements.

3. *Sample Identification (Form 1923)* – This form must be submitted when material sampling is required on a project. QAI must completely fill out the form and keep a copy in the fabrication inspection folder.

4. *Bar Reinforcement Report (Form 1985)* – This form is only used if QAI performs QA verification inspection on bar reinforcement for prefabricated bridge element systems (PBES) or other products that contain complex reinforcement as directed by the Engineer.

5. *Pre and Post Pour Inspection Checklist (Form 5616)* – This checklist must be completed by QAI for a minimum of one element per project.

6. *Field and Lab Test Report (Form 0590)* – This form must be completed by QAI for each pour which may contain several products.

7. *Repair Observation Report (Form 1981)* – This form is only used if QAI performs QA verification inspection on R-2 mortar repair procedures or as directed by the Engineer for

repairs that have been approved by the Engineer.

8. *Materials Source List (Form 0501)* – This form is submitted by the fabricator. The QAI will verify that the fabricator filled out the form completely and document the basis of acceptance for all materials. If there are any materials that require testing, then the SFU must be copied on the completed MSL to coordinate the acceptance testing.

2.1.6 Stockpile Payment

This stockpile payment section directs the QAI on the requirements when stockpile payment inspection is requested by the SFU. The QAI must perform the following steps:

1. Verify fabricated material meets approved shop drawings (if applicable).
2. Verify stockpile quantity and include quantity in report.
3. Verify material is labeled for MDOT use only.
4. Verify material is correctly stored and protected from the weather; and
5. Provide a report summarizing the inspection and provide adequate photos that represent the general condition of the products, how they are being stored, and piece marks.

2.1.7 Acceptance

A. Bill of Lading

The Fabricator is required to provide the QAI with a minimum of five (5) copies of the Bill of Lading for each shipment. QAI will stamp each copy of the Bill of Lading with the MDOT "Approved for Use" stamp and will retain one copy for their records. It is the Fabricator's responsibility to distribute the remaining copies of Bill of Lading to the following individuals:

1. Engineer
2. Contractor
3. Trucking company

The Bill of Lading is required to contain, at a minimum, the following information:

1. Shipping date
2. Description of cargo (quantity, element size, weight, etc.)
3. Element unique piece mark
4. MDOT project location (route, crossroad/river, and city)
5. MDOT project information (structure number, control section, and job number)
6. Manufacturer's name and address

B. Acceptance Process

Acceptance consists of the following two-part process:

1. Fabrication Inspection Acceptance:

Structural products must be inspected by the QAI after they are loaded for shipping. If the structural products meet the contract requirements, the QAI will stamp them "Approved for Use". The products must be stamped "Approved for Use" prior to shipping. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for

use by the Department and does not relieve the Contractor of their responsibility to meet contract requirements.

2. Visual Inspection (VI) Acceptance:

The Engineer must collect one copy of the stamped Bill of Lading and use it to verify the delivered structural products. Additionally, the Engineer must verify that the products are stamped and visually inspect them for signs of damage that may have occurred as a result of shipping and handling. This visual inspection should be documented in the field inspector's daily report.

2.2 Prestressed Structural Precast Concrete Fabrication

2.2.1 Scope

This prestressed structural precast concrete fabrication inspection procedure should be used to aid the QAI in interpreting and enforcing the contract for prestressed concrete products. Fabrication inspection includes the time from verifying materials used for fabrication through loading for shipping to the construction site. The following prestressed structural precast concrete products are inspected using this procedure:

1. Bridge main members
2. Bridge secondary members
3. Culverts
4. Prefabricated bridge element systems
5. Noise barrier wall posts and panels
6. Other products as specified in the contract or directed by the Engineer

2.2.2 Reference Documents

A. QAI must have a thorough knowledge of the following references:

1. The following sections of the *MDOT Standard Specifications for Construction (MDOT SSC)* as modified by *Supplemental Specification 12SS-001A Errata*, as applicable:
2. The following *Frequently Used Special Provisions (FUSP)*, as applicable:

12SP-105A	Source of Steel and Iron (Buy America)
12SP-707I	Structural Steel Diaphragms for Prestressed Concrete Beams
12SP-708A	Strand Debonding
12SP-708B	Prestressed Concrete Bulb-Tee Beam
12SP-708C	QC and Acceptance of Structural Precast Concrete
12SP-826J	Spun Concrete Pole and Drilled Shaft Foundation
12SP-905A	Steel Reinforcement Revisions
12SP-911A	Water

3. *MDOT Structural Precast Concrete QAI Manual*
4. *MDOT Materials Source Guide (MSG)*
5. Prefabrication meeting minutes (if available)

B. QAI must be familiar with the following references:

1. *MDOT Structural Fabrication Request for Information Process*
2. *MDOT Structural Fabrication Nonconformance Process*
3. Michigan Test Methods

MTM 108	Michigan Test Method for Materials Finer than No. 75 Sieve in Mineral Aggregates by Washing

MTM 109	Michigan Test Method for Sieve Analysis of Fine, Dense Graded, Open Graded, and Coarse Aggregates in the Field
MTM 110	Michigan Test Method for Determining Deleterious and Objectionable Particles in Aggregates

4. ASTM Standards

C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 94	Standard Specification for Ready-Mixed Concrete
C 138	Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete
C 143	Standard Test Method for Slump of Hydraulic Cement Concrete
C 172	Standard Practice for Sampling Freshly Mixed Concrete
C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
E 29	Standard Practice for using Significant Digits in Test Data to Determine Conformance with Specifications

5. PCI MNL-116 Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
6. PCI Safety and Loss Prevention Manual SLP-100
7. MDOT Accident Prevention Plan

2.2.3 Qualifications, Responsibilities, Duties, and Equipment

2.2.3.1 Qualifications of the QAI

QAI performing the fabrication inspection must possess the following qualifications:

1. Michigan Professional Engineer (PE) license or Precast/Prestressed Concrete Institute (PCI) Technician Level II.
2. Michigan Concrete Association (MCA) Level I Field Testing Technician certification or American Concrete Institute (ACI) Concrete Field Testing Technician – Grade I (except period of effectiveness will be reduced from 5 years to 3 years to match MCA); and
3. If aggregate sampling or testing is performed, QAI must possess the necessary Michigan Certified Aggregate Technician (MCAT) Level I, Level II, or Aggregate Sampling certification.

2.2.3.2 Responsibilities of the QAI

QAI performing the fabrication inspection is not permitted to make changes to the contract and has the following responsibilities:

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction. QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection to produce a

product satisfying the contract. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

QAI is the responsible party, representing the Engineer, who performs quality assurance verification inspection on the element after QC inspects and approves the item of work. The QAI must provide inspection during fabrication as directed by the Engineer and must perform each inspection item shown in subsection 2.2.4.3 thru 2.2.4.10 a minimum of once per project or per the project ITP whichever is more frequent. If issues arise, it will be at the Engineer's discretion whether to increase the level of QA inspection.

It is the Engineer's responsibility to engage the EOR when making structural decisions. The Engineer is also responsible for following internal MDOT procedures for review and approval of shop drawings, fabrication procedures, RFIs, NCRs, and for professional decision making on fabrication problems that arise. The Engineer relies on the SFU to manage and assist when appropriate. The Engineer has the prerogative for holding a prefabrication meeting with the Fabricator to discuss and clarify the contract plans and specifications. The Engineer is the responsible party who ensures MDOT's fabrication QA program is followed for inspection and acceptance of the element.

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the SFU is aware of this activity and await instruction on how to proceed. If the Engineer permits the work to proceed without approved shop drawings, proceed with basic QA functions using the non-approved shop drawings. Later, verify notes against approved drawings. Notify the SFU immediately if fabrication is not in conformance with the approved shop drawings.

2.2.3.3 Duties of the QAI

QAI performing the fabrication inspection has the following duties:

1. QAI must thoroughly understand the contract.
2. QAI must verify steel material certifications show compliance with Buy America contract requirements.
3. QAI must be proficient in performing fresh concrete tests, sampling aggregate and other materials, verifying material traceability, and inspecting concrete pours.
4. QAI must be proficient in writing reports and using computers.
5. QAI must notify the Engineer if production begins before approved shop drawings are on the shop floor and provided to the QAI.
6. QAI must communicate all concerns through QCI or whomever the Fabricator directs during the prefabrication meeting.
7. QAI must communicate with QCI to obtain the work schedule.
8. QAI must follow *MDOT's Structural Fabrication E-Construction Process* for closing out fabrication inspection file.

2.2.3.4 Deficiencies on Local Agency Projects

MDOT's QAI must notify the SFU if they observe fabrication or inspection deficiencies on local agency program (LAP) projects. The Structural Fabrication Engineer will report the deficiencies via email to the Engineer that is responsible for construction oversight of the local agency project and carbon copy the applicable CFS and Design Division LAP Engineers.

2.2.3.5 Inspection Facilities and Access

Facilities for the QAI must be provided by the Fabricator per contract. QAI must always have access to all parts of the work. The authority and general duties of the QAI are specified in Section 104.01.D and E of the MDOT SSC.

2.2.3.6 Inspection Equipment

QAI will be furnished with the following items by the Engineer:

1. Contract (MDOT SSC, special provisions, standard plans, special details, plan sheets, etc.)
2. Approved shop drawings (provided by Fabricator)
3. MDOT shop approval stamp
4. Numbered plastic sample tags, sampled adhesive tags for material sampling, and numbered metallic MDOT sample tags

QAI must provide the following inspection equipment:

1. Computer with high speed internet access
2. Cell phone
3. Digital Camera (can be integral with cell phone)
4. Flashlight
5. Temperature measuring devices capable of covering the range from 0°F to 200°F
6. Fresh concrete testing equipment (thermometer, slump cone kit, and air-meter)
7. Measuring devices (200 foot and 20-foot steel tape and calipers)
8. Straightedge and levels
9. Safety equipment
10. Other as needed for the project

2.2.4 Inspection Procedure

2.2.4.1 Prefabrication Meeting

Prefabrication meetings facilitate effective quality control and quality assurance on the project and are conducted by the SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must be present, whereas the Engineer and Contractor should be present to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective communication.

2.2.4.2 Inspection Overview

Prestressed concrete must be fabricated in accordance with the MDOT SSC and the contract. Fabrication inspection is performed in accordance with the ITP specified in the MDOT work assignment.

1. Prestressed concrete fabrication inspection consists of verifying compliance with the approved shop drawings, contract, and approved NCRs. RFIs must be incorporated into the

approved shop drawings for the QAI to inspect to.

2. An approved Materials Source List (MSL), submitted by the Fabricator to the MDOT Structural Fabrication Unit and the Engineer for review and approval, is provided to the QAI. The QAI reviews what materials are being incorporated into the project and documents the basis of acceptance for each material. The MSL is used to track material sampling by the QAI and to foster communication with QCI to ensure all required sampling and testing occurs in a timely manner to prevent impacts to the project schedule. It is the Fabricator's responsibility to notify the QAI when materials are available for sampling.

3. QAI begins by inspecting materials that will be used in the fabrication process and ensures they are being stored correctly, tagged for traceability purposes, and are in conformance with the contract. Next, the QAI inspects the Fabricator's operations to ensure the condition of the equipment and work area for conformance to the contract.

4. MDOT's Accident Prevention Plan states, "MDOT employees shall not engage in any act which would endanger another employee or themselves". QAI must notify the Engineer immediately if work conditions exist that are not safe. If the level of inspection diminishes below what is specified in this QA procedure, due to safety concerns, then the element will not be approved for use.

2.2.4.3 Strand Verification

General Information – While the strand is still visible, the QAI must inspect the strands to assure that they are free of oil or other foreign material. Strands not free of oil or foreign material, or that contain kinks, bends, nicks, or other defects (including scale or excessive rust) will be brought to QCs attention that incorporation of these nonconforming strands will render the element unacceptable and the element will not be approved for use.

A. Strands are positioned to duplicate the strand pattern shown on the approved shop drawings. Changing the vertical position of the strands must have the approval of the Engineer. Changing the horizontal position of the strands to simplify fabrication or to accommodate two strand patterns on a bed is permitted provided the following is still achieved:

   1. Specified concrete cover.

   2. Center to center distance of strands is at least 2 inches.

   3. Number of strands per row is maintained; and

   4. Resulting strand pattern is symmetrical about the vertical centerline of the element.

B. Two strand patterns are permitted to be combined on a casting bed provided the following conditions are met and approved by the Engineer:

   1. Bond breaker must be placed on each of the unrequired strands for the full length of each element. Bond breaker (rigid, oversized, and monolithic) material requires the approval of the Engineer.

   2. Maximum of two full length debonded strands per element.

C. All supports used to position the strand rows must be of adequate thickness to hold the true position of the strands.

D. Inspection of the tensioning operation consists of verifying the jack is calibrated and observing the accurate introduction of the initial load in each of the strands. Final stressing of the strands is performed by application of load into each strand or all the strands at once to produce an elongation equaling a ***net elongation*** (gross elongation minus live end seating). The QAI must verify the allowable stress in each strand by measuring the ***net elongation*** of the individual

strands after the final stressing. The maximum load applied to each strand, as indicated by the pressure gauge of the tensioning device, is also recorded for back checking.

E. QAI must complete independent strand tensioning calculations for verification purposes with QC.

2.2.4.4 Strand Tensioning

The QAI must verify the load (measured in pounds) and elongation (measured in inches) applied to each strand using the following procedures:

A. Initial Load

After all strands are positioned on the casting bed each strand is secured by a strand-vise at the dead-end anchoring bulkhead of the casting bed. Each strand is individually fitted at the live end anchoring bulkhead (tensioning end) of the casting bed and an ***initial load*** is applied either one strand at a time or all at once. The ***initial load*** must be designated by the Fabricator and must be within 5 and 25% of the final load. Allow a ±100 lb. measurement tolerance for loads less than or equal to 10% of the final load, and a ±200 lb. measurement tolerance for loads greater than 10% of the final load.

When the ***initial load*** is reached, a reference mark is made on the strand on the outside of the live end anchoring bulkhead such that measurement of continued elongation can be observed. The purpose of applying an ***initial load*** to each strand is to establish a constant starting point for measuring the ***net elongation*** measurements by eliminating slack in the system.

B. Final Load

Final load is the force required beyond ***initial load.*** At this time, the strand pattern is checked at each bulkhead to make certain all strands are in their correct position and none of the strands are crossed.

C. Net Elongation

Using the strand mark from the previous step (after initial load) the final load is applied to the strand. The distance between the strand mark and the reference point must be measured to the nearest 0.0625 inches to determine when the ***net elongation*** *is reached*. If the measured elongation is equal to or slightly greater than (5 percent or less) the computed elongation, the tensioning operation is complete.

Changes in live end seating loss over time may result in insufficient over-pull. PCI requires the plant personnel to monitor the changes and adjust the required over-pull accordingly. If there is a need for arbitration a reasonable approach is suggested here for a predetermined number of strands. When the tensioning operation for each strand is complete and before the tension is released from the jack, a second reference mark must be made on the strand at the inside of the anchoring plate and the strand-vise must then be tapped into position against the outside face of the anchoring plate. When the tension has been released from the jack the QAI must check the reference marks on the strand at the inside of the anchoring plate to determine that no slippage of the strand-vise (live end seating loss) has occurred. If slippage has occurred, then it must be compared to the assumed live end seating loss used in the strand tensioning calculations.

D. Strand Elongation

The tensioning operation must be stopped immediately whenever the strand is elongating without a corresponding increase in the load, or the load increases without a continuing increase in strand elongation. In these occurrences, the following steps must be taken:

1. Strand elongation computation is checked.
2. Casting bed length is verified.
3. Modulus of elasticity of the strand is verified; and
4. Factors restricting the free movement of the strand are reviewed.

Temperature changes may affect the hydraulic system of the tensioning apparatus resulting in variations in load readings.

E. Tensioning Draped Strands

QAI must be alert to the strand elongation and tensioning operation discussed above. In some cases, the number and efficiency of hold-down/hold-up hardware may restrict the free movement of a strand over the entire bed length resulting in a continuing elongation of strand without a corresponding increase in the load. When this situation occurs, the tensioning operation is stopped and the remaining elongation developed in the strand taken by tensioning the strand from the opposite end of the casting bed.

F. Confirming Uniform Elongation of Draped Strands

This can be accomplished by marking-off a 10-foot (or more if available) length of draped strand at the opposite end of the bed after the initial load operation has been completed. At the completion of the final measured elongation operation, the measured distance between the marks should have increased to the ***net elongation*** computation for a 10-foot strand length (or whatever was initially marked off).

G. Wire Failure in Strand

See PCI MNL 116 for acceptance of failure of individual wires in a pretensioning strand.

2.2.4.5 Forming and Casting

1. General Information

QAI must confirm the dimensional requirements of the bulkheads, side forms, bearing plates, steel reinforcement, void boxes, inserts, and any other devices per the approved shop drawings as part of their post-pour inspection. The only exception is that anything that cannot be inspected post-pour, must be inspected during pre-pour. It is important to emphasize that QA must not supersede QC so the QAI's inspection must come after QC has completed their inspection and approves the element. QAI then uses the QC inspection reports (if available) during their verification inspection.

2. Concrete Forms - Concrete forms must be maintained and remain true to the shapes and dimensions as shown on the approved drawings.

    d. Metal forms must be used since they are designed and aligned to not restrict the longitudinal movement of the casting when the prestressing force is transferred. Forms must be well braced and stiffened against undesirable deformations under pressure of fresh concrete and must have smooth joints and inside surfaces accessible for adequate cleaning after each use.

    e. Joints between panel forms must be made and maintained smooth and tight. Unless otherwise shown on approved shop drawings, all corners or intersections of surfaces exposed in the completed structure must be chamfered with a minimum dimension of 0.50 inches and all re-entrant angles must be rounded with a minimum radius of 0.75 inches.

    f. Forms that are warped, distorted, damaged, or improperly cleaned must not be used. Wood forms may be used for bulkheads. The inside faces of all forms must be coated with an approved chemical release agent.

3. Reinforcing Steel

QAI must confirm that the reinforcing steel is of the correct size, free from defects, and properly positioned. The reinforcing steel must be free of oil, lubricants, foreign material, and excessive rust. If epoxy coated bars are to be used, then nicks in the coating are not permitted.

QAI must spot check that the reinforcing steel has been properly positioned and secured in accordance with the approved shop drawings and make certain that inserts have been placed where required.

4. Void Boxes

Void boxes must be of the dimensions and positioned in the form in accordance with the approved shop drawings.

After the bar reinforcement assembly has been positioned in the formwork, the QAI must confirm that the void boxes are securely clamped to the formwork so they cannot move out of position during consolidation activities. After the unit has been cast, and immediately after the top has been struck-off, the top slab thickness must be confirmed by the QAI to assure that there has been no upward movement of the void box and that the top slab thickness is within the acceptable specification limits. The depth of concrete over the void boxes will be spot checked and any concerns noted and immediately shared with QC.

5. Tests on Fresh Concrete

QAI must perform testing as required in the contract and document the results in MDOT Form 0590. The Fabricator must collect additional fresh concrete for QAI to perform their tests as needed.

6. Placing of Concrete

The concrete must be promptly placed with minimum handling to avoid segregation of the materials and the displacement of the reinforcement. Each element must be cast in a continuous operation with minimal interruption between the placing of adjacent portions of concrete and each layer must be placed and consolidated before the preceding layer has taken initial set.

7. Consolidation of Concrete

A minimum amount of vibration necessary to thoroughly consolidate the concrete must be used. QAI must verify a rubber coated vibrator head is used when epoxy-coated or other coated reinforcement is used.

2.2.4.6 Transfer of Prestress

The tension in the strands must not be transferred to the concrete in the element until the concrete has attained the required compressive strength as indicated by test results of QC compressive strength test cylinders which have been cast and match cured per the contract.

1. Forms are removed, and the strands are released by simultaneously cutting both ends of the same strand using a torch or other method approved by the Engineer. The Fabricator must release strands in a symmetrical pattern about the vertical centerline. Extreme care must be exercised by the Fabricator to avoid damaging the concrete by superheating it with the torch.
2. Products are moved from the casting bed to the yard upon completion of the transfer of prestress. After removal from the bed, the QAI must immediately inspect the element for any defects created during casting and perform post-pour inspections after QC has completed their inspection and approves the element. QAI must note any deficiencies on Form 5617 and immediately notify the Fabricator and Engineer. The Engineer may request the QAI to complete a QA NCR and arrange a meeting with QC to discuss why the

deficiency was not caught by QC.

2.2.4.7 Curing Requirements

Curing requirements for prestressed concrete must be as specified in subsection 708.03 of the MDOT SSC as modified by the contract. When steam or radiant heat curing is used, recording thermometers must be provided by the Fabricator that monitors the time/temperature relationship through the curing period while artificial heat is used. The QAI must verify that the recording thermometers are placed in critical locations for monitoring the time/temperature relationship during the curing period. Verify QC has the required number of recording thermometers per the contract and they are placed at locations where the anticipated heat generated by the concrete is the lowest and highest just after initial concrete set. Documentation from the Fabricator's recording thermometer must be given to the QAI for their review. Temperature requirements during the curing operation must be in accordance with the contract specifications.

2.2.4.8 Material Requirements

Materials must meet the requirements of the contract unless an RFI requesting alternate materials has been approved by the Engineer.

2.2.4.9 Shipping Requirements

Products must attain the required compressive strength as indicated by test results of QC compressive strength test cylinders, which have been cast and match cured for this purpose as described per the contract. These cylinders must be cast with numbered metallic MDOT sample tags.

2.2.4.10 Concrete Compression Strength Testing

QAI must witness concrete strength testing at the sampling frequency of the governing ITP. Watch for specimen ID, handling, machine condition, and QC procedural compliance. Verify proper interpretation and reporting of results by the QCI.

2.2.5 Reports

A. The Engineer may require a periodic status report from the SFU; therefore, all reports are required to be completed in a timely and orderly manner using the applicable forms listed below that can be found on MDOT's website. Make entries as soon as possible after an event or conversation to ensure accuracy. Number the reports consecutively until completion of the work with the last report noted "final".

B. QAI must complete an accurate and detailed account of fabrication for the project. The report must include a discussion of fabrication progress for all aspects of the work. It is intended to be a detailed record of the status of fabrication and should include number of products fabricated, documentation of specification and procedure compliance as well as documentation of conflicts, repairs, and other problems or discussion which could affect the project in any way. If force account work is taking place, document each day that the work occurs in the shop and which products are being worked on.

C. Documentation is not a substitute for appropriate dialogue with the Fabricator but should provide a record of important discussions. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the SFU's correspondence.

D. Reports must be assembled into one fabrication inspection portable document format (PDF) file and stored in MDOT's ProjectWise document storage program per MDOT's SFU's E-Construction *Process*. The Engineer will receive a fabrication inspection memorandum from the Structural

Fabrication Engineer after fabrication inspection is complete. The memorandum is for informational purposes and is not used for acceptance.

E. Below is a list of various MDOT reports/forms and a brief description of their purpose and use requirement. Similar forms can be used in place of the standard MDOT form if noted below. All completed forms or equivalent forms are placed in the fabrication inspection file at the end of the project.

1. Project Folder Checklist (Form 2001) – This form must be completed by QAI for each project. The checklist is placed on top of the fabrication inspection file when the project is complete.
2. Shop Inspection Report (Form 5617) – This form (or the consultant's company form) must be completed by QAI on a weekly basis for each project and should contain a brief narrative of the work performed over the reporting period and include photos when necessary while omitting emotions and personal feelings. Refer to the Narrative Report Writing section earlier in this document for requirements.
3. Sample Identification (Form 1923) – This form must be submitted when material sampling is required on a project. QAI must completely fill out the form and keep a copy in the fabrication inspection file.
4. Strand Tensioning Report (Form 0513) – This form must be completed by QAI for each bed, which may contain several products.
5. Bar Reinforcement Report (Form 1985) – This form is only used if QAI performs QA verification inspection on bar reinforcement for prefabricated bridge element systems (PBES) or other products that contain complex reinforcement as directed by the Engineer.
6. Pre and Post Pour Inspection Checklist (Form 5616) – This checklist must be completed by the QAI.
7. Field and Lab Test Report (Form 0590) – This form must be completed by QAI for each pour which may contain several products.
8. *Repair Observation Report (Form 1981)* – This form is only used if QAI performs QA verification inspection on R-2 Mortar repair procedures or as directed by the Engineer for other types of repairs.
9. *Materials Source List (Form 0501)* – This form is submitted by the fabricator. The QAI will verify that the fabricator filled out the form completely and document the basis of acceptance for all materials. If there are any materials that require testing, then the SFU must be copied on the completed MSL to coordinate the acceptance testing.

2.2.6 Stockpile Payment

This stockpile payment section directs the QAI on the requirements when stockpile payment inspection is requested by the SFU. The QAI must perform the following steps:

1. Verify fabricated material meets approved shop drawings (if applicable).
2. Verify stockpile quantity and include quantity in report.
3. Verify material is labeled for MDOT use only.
4. Verify material is correctly stored and protected from the weather; and
5. Provide a report summarizing the inspection and provide adequate photos that represent

the general condition of the products, how they are being stored, and piece marks.

2.2.7 Acceptance

A. Bill of Lading

The Fabricator is required to provide the QAI with a minimum of five (5) copies of the Bill of Lading for each shipment. QAI will stamp each copy of the Bill of Lading with the MDOT "Approved for Use" stamp. It is the Fabricator's responsibility to distribute the stamped copies of Bill of Lading to the following individuals:

1. Engineer
2. Contractor
3. Trucking company

The Bill of Lading is required to contain, at a minimum, the following information:

1. Shipping date
2. Description of cargo (quantity, element size, weight, etc.)
3. Element unique piece mark
4. MDOT project location (route, crossroad/river, and city)
5. MDOT project information (structure number, control section, and job number)
6. Manufacturer's name and address

B. Acceptance Process

Acceptance consists of the following two-part process:

1. Fabrication Inspection Acceptance: Structural products must be inspected by the QAI after they are loaded for shipping. If the structural products meet the contract requirements, the QAI will stamp them "Approved for Use". The products must be stamped "Approved for Use" prior to shipping. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for use by the Department and does not relieve the Contractor of their responsibility to meet contract requirements.
2. Visual Inspection (VI) Acceptance: The Engineer must collect one copy of the stamped Bill of Lading and use it to verify the delivered structural products. Additionally, the Engineer must verify that the products are stamped and visually inspect them for signs of damage that may have occurred as a result of shipping and handling. This visual inspection should be documented in the field inspector's daily report.

2.3 Structural Steel Fabrication

2.3.1 Scope

This structural steel fabrication inspection procedure should be used to aid the QAI in interpreting and enforcing the contract for structural steel products. Fabrication inspection includes the time from verifying materials used for fabrication through loading for shipping to the construction site. The following products are inspected using this procedure:

1. Bridge main member
2. Bridge secondary member
3. Bridge bearings
4. Bridge grid deck and sidewalks
5. Bridge railing
6. Other products as specified in the contract or directed by the Engineer

2.3.2 Reference Documents

A. QAI must have a thorough knowledge of the following references:

1. The applicable sections of the *MDOT Standard Specifications for Construction (MDOT SSC)* as modified by *Supplemental Specification 12SS-001A – Errata*.
2. The following *Frequently Used Special Provisions (FUSP)*, as applicable:

12SP-105A	Source of Steel and Iron (Buy America)
12SP-707A	Special Provision for Structural Steel and Aluminum Construction
12SP-707B	Special Provision for Fracture Critical Members
12SP-707C	Special Provision for Modular Expansion Joint System
12SP-707F	Special Provision for Structural Steel Construction Revisions
12SP-707G	Special Provision for Prefabricated Pedestrian Bridge, Type 1
12SP-707H	Special Provision for Prefabricated Pedestrian Bridge, Type 2
12SP-707I	Special Provision for Structural Steel Diaphragms for Prestressed Concrete
12SP-716A	Special Provision for Shop Cleaning and Coating Structural Steel Revisions
12SP-906B	Special Provision for Structural Steel Revisions

3. *MDOT Structural Steel QAI Manual*
4. AASHTO/AWS D1.5, Bridge Welding Code (as modified by 12SP-707A, Structural Steel and Aluminum Construction), hereafter called AWS D1.5
5. AWS D1.1, Structural Welding Code – Steel (as modified by 12SP-707A, Structural Steel and

Aluminum Construction), hereafter called AWS D1.1

6. *MDOT Materials Source Guide (MSG)*
7. Prefabrication meeting minutes (if available)

B. QAI must be familiar with the following references:

1. AWS 2.4, Symbols for Welding and Nondestructive Testing
2. AWS A3.0, Standard Welding Terms and Definitions
3. *MDOT Structural Fabrication Request for Information Process*
4. *MDOT Structural Fabrication Nonconformance Process*
5. Applicable SSPC specifications
6. Applicable coating test methods
7. Applicable ASTM and AASHTO specifications
8. MDOT Accident Prevention Plan

2.3.3 Qualifications, Responsibilities, Duties, and Equipment

2.3.3.1 Qualifications of the QAI

QAI performing the fabrication inspection must possess an active AWS Certified Welding Inspector (CWI) certification.

2.3.3.2 Responsibilities of the QAI

QAI performing the fabrication inspection is not permitted to make changes to the contract and has the following responsibilities:

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction. QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection to produce a product satisfying the contract. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

QAI is the responsible party, representing the Engineer, who performs quality assurance verification inspection on the product after QC inspects and approves the item of work. The QAI must provide inspection during fabrication as directed by the Engineer and must perform each inspection item shown in section 2.3.4.3 thru 2.3.4.7 a minimum of once per project or per the project ITP whichever is more frequent. If issues arise, it will be at the Engineer's discretion whether to increase the level of QA inspection.

It is the Engineer's responsibility to engage the EOR when making structural decisions. The Engineer is also responsible for following internal MDOT procedures for review and approval of shop drawings, fabrication procedures, RFIs, NCRs, and for professional decision making on fabrication problems that arise. The Engineer relies on the SFU to manage and assist when appropriate. The Engineer has the prerogative for holding a prefabrication meeting with the Fabricator to discuss and clarify the contract plans and specifications. The Engineer is the responsible party who ensures MDOT's fabrication QA program is followed for inspection and acceptance of the product.

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the SFU is aware of this activity and await instruction on how to proceed. If the Engineer permits the work to proceed without approved shop drawings, proceed with basic QA functions using the non-approved shop drawings. Later, verify notes against approved drawings. Notify the SFU immediately if fabrication is not in conformance with the approved shop drawings.

2.3.3.3 Duties of the QAI

QAI performing the fabrication inspection has the following duties:

1. QAI must thoroughly understand the contract.
2. QAI must verify steel material certifications show compliance with Buy America contract requirements.
3. QAI must be proficient in testing welders, sampling materials, verifying material traceability, and inspecting welds and coating systems.
4. QAI must be proficient in writing reports and using computers.
5. QAI must notify the Engineer if production begins before approved shop drawings are on the shop floor and provided to the QAI.
6. QAI must communicate all concerns through QCI or whomever the Fabricator directs during the prefabrication meeting.
7. QAI must communicate with QCI to obtain the work schedule.
8. QAI must follow *MDOT's Structural Fabrication E-Construction Process* for closing out fabrication inspection file.

2.3.3.4 Deficiencies on Local Agency Projects

MDOT's QAI must notify the SFU if they observe fabrication or inspection deficiencies on local agency program (LAP) projects. The Structural Fabrication Engineer will report the deficiencies via email to the Engineer that is responsible for construction oversight of the local agency project and carbon copy the applicable CFS and Design Division LAP Engineers.

2.3.3.5 Inspection Facilities and Access

Facilities for the QAI must be provided by the Fabricator per contract. QAI must always have access to all parts of the work. The authority and general duties of the QAI are specified in Section 104.01.D and E of the MDOT SSC.

2.3.3.6 Inspection Equipment

QAI will be furnished with the following items by the Engineer:

1. Contract (MDOT SSC, special provisions, standard plans, special details, plan sheets, etc.)
2. Approved shop drawings (provided by Fabricator)
3. MDOT shop approval stamp
4. Numbered plastic sample tags and sampled adhesive tags for material sampling
5. Plastic bags for sampling high strength bolts

QAI must provide the following inspection equipment:

1. Computer with high speed internet access
2. Cell phone
3. Digital camera (can be integral with cell phone)
4. Flashlight
5. Fillet weld gauges
6. Undercut gauges
7. Instrumentation for measuring voltage and amperage
8. Temperature measuring devices capable of covering the range from 0°F to 1650°F
9. Dry film thickness gauges
10. Wet film paint thickness gauge
11. Surface roughness comparator gauge
12. Extra course replica tape for measuring blasted steel surface profile
13. SSPC book of pictorial blast standards
14. Temperature and humidity measuring instruments
15. Measuring devices (200 foot and 20-foot steel tape and calipers)
16. Straightedge and levels
17. Safety equipment
18. Other as needed for the project

2.3.4 Inspection Procedure

2.3.4.1 Prefabrication Meeting

Prefabrication meetings facilitate effective quality control and quality assurance on the project and are conducted by SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must be present, whereas the Engineer and Contractor should be present to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective communication.

2.3.4.2 Inspection Overview

Structural steel must be fabricated in accordance with the MDOT SSC and contract. Fabrication inspection is performed in accordance with the ITP specified in the MDOT work assignment and as shown below:

1. Structural steel fabrication inspection consists of verifying compliance with the approved shop drawings, contract, and approved NCRs. RFIs must be incorporated into the approved shop drawings for the QAI to inspect to.
2. An approved Materials Source List (MSL), submitted by the Fabricator to the MDOT Structural Fabrication Unit and the Engineer for review and approval, may be provided to the QAI. The QAI reviews what materials are being incorporated into the project and documents the basis of acceptance for each material. The MSL is used to track material sampling by the QAI and to foster communication with QC to ensure all required sampling and testing

occurs in a timely manner to prevent impacts to the project schedule. Structural steel projects typically only include high strength and anchor bolt materials; however, since this material is shown in the approved shop drawings an MSL is not required. The MSL does prove to be very useful for complex projects and may be required by the Engineer. It is the Fabricator's responsibility to notify the QAI when materials are available for sampling.

3. QAI begins by inspecting materials that will be used in the fabrication process and ensures they are being stored correctly, tagged for traceability purposes, and are in conformance with the contract. Next, the QAI inspects the Fabricator's operations to ensure the condition of the equipment and work area for conformance to the contract.

4. MDOT's Accident Prevention Plan states, "MDOT employees shall not engage in any act which would endanger another employee or themselves". QAI must notify the Engineer immediately if work conditions exist that are not safe. If the level of inspection diminishes below what is specified in this QA procedure, due to safety concerns, then the product will not be approved for use.

2.3.4.3 Before Welding

Below is a checklist for the QAI to use for fabrication inspection prior to the start of welding. The actual steps and their exact sequence will depend upon the type of structure, the method of erection, and the qualifications of the welders who are to do the work.

1. Verify mill test reports match the base metal for conformance with the specifications. Verify that QC is maintaining traceability of all materials to such degree that the heat number of each piece of steel that is used in the project can be tracked to its location in the structure. Obtain from the Fabricator, if necessary, the shipping records, storage locations, and scheduling for each piece of steel that they intend to use in connection with the assigned contract. Examine each piece of steel as it is received at the shop to see that it has no uncorrected defects, kinks, or bends resulting from improper handling while in the mill or shop or in transit from mill to shop. Verify that the material from the mill meets ASTM A6.

2. Verify all welders are MDOT qualified (see *MDOT's Welder Qualification Program*) and have appropriate fracture critical qualification, if applicable. Require requalification or supplementary welder tests if there are concerns. MDOT's SSC requires that all tack welders, welders, and welding operators are current MDOT qualified welders for the welding process, plate thickness, and position prior to welding.

3. Verify that the WPS and welding sequences are agreed to and understood by QAI, QC, and Fabricator prior to welding. All WPSs and PQRs are required to be reviewed and approved by the SFU. The Contract requires all WPSs to be qualified as required in the related welding code prior to welding. This qualification requirement is inclusive of all types of welds (butt welding, fillet welding, seal welding, plug welding, etc.). MDOT will accept prequalified WPSs if they meet all the prequalification requirements of the welding code. MDOT also accepts properly documented evidence of previous PQRs that have not expired. See the contract for specific WPS and PQR requirements. The Fabricator is required to post approved WPS's at each welding station.

4. Make a general examination of the structural steel and verify the quality of fabrication. Pay attention to the plate edge preparation, which would affect control over welding. Notify QC of any observed deficiencies before weld joint fit up is complete so they can correct any deficiencies.

5. Check the fitting of joints that are to be welded, including dimensions of root face, angle of bevel, cleanliness, match marks, alignment of parts to be joined, and uniformity and size of root openings. Recheck root faces and angles of bevel because trimming and re-beveling of plate edges is sometimes performed during fitting. Check the prepared weld joint edges

for evidence of possible undesirable internal defects such as laminations in the steel plate. Make dimensional checks of all critical measurements to assure a proper fit in the field.

6. Check the fixture, clamping, and pre-cambering arrangements used in the fabrication assembly setup for adequacy. Make certain tack welds are made by MDOT qualified welders and the welds are small, smooth, and of specified quality. Verify that runoff tabs or extension plates are in place to ensure complete welding beyond the plate edges.

2.3.4.4 During Welding

1. Verify all welding is being performed using the approved WPS and sequences (if applicable) and electrodes are used with suitable currents and polarity for the positions the electrodes are intended to be used. Refer to the approved WPS for all details of performing the weld in question.

2. During inclement weather, ensure that suitable windbreaks or shields are provided, and welding is not performed on surfaces that are wet, exposed to rain or snow, or if a heavy fog is present. Check the ambient and steel temperatures at the start of welding and during welding to determine if the specified preheat and interpass temperature requirements are being observed. Use temperature-indicating crayons or other equivalent means to check these temperatures.

3. Check to make certain the correct electrodes (type and size) are available and are properly dried to prevent porosity and hydrogen cracking in the final welds. Low-hydrogen electrodes are susceptible to these types of defects if they are exposed to the atmosphere beyond the recommended limits. If electrodes and fluxes have been improperly stored or exposed to humidity in excess of the recommended limits, notify QC that reconditioning or rejection is required per the contract.

4. Intermittently observe the technique and performance of each welder to verify the approved WPS and suitable techniques are being followed. Inspect important or unique joints multiple times to ensure all weld passes meet project specifications. Arrange for the welder or the foreman to notify the QAI when such inspections at various stages may be made. Report any unusual or excessive distortion during welding to QC. Verify all corrective measures are being followed as approved by the Engineer to ensure the Fabricator's methods minimize locked-in stresses.

5. Verify the welding arc is only struck in the joint or other area on which metal is to be deposited and not at random locations on the base metal outside of the prepared joint. Arc strikes cause physical and metallurgical stress risers and can change the mechanical properties of the steel at isolated locations. These changes can result in fatigue failures. Verify that approval by the Engineer has been given to the Fabricator prior to ground bars, clips, or ties being welded to the base metal. Approval for such welding is only given by the Engineer when unavoidable. When steel ground bars are used instead of ground clamps to carry the welding current to the base metal, make certain the ground bars are carefully welded to the base metal at a runoff tab or securely clamped to any area where all mill scale has been removed. Verify the grounding lead is as close to the point of welding as is practical.

6. Inspect root passes with special care because it is very important the first weld materials deposited in the root of a multiple pass weld is properly performed. Closely examine the root pass in important complete joint penetration welds, such as flange and web butt welds, t-joint, and corner joints to verify a sound pass that is free from cracks, inclusions, and lack of fusion.

7. Verify the root pass and every subsequent weld pass is cleaned with a wire brush and chipping hammer to thoroughly remove slag between weld passes to avoid inclusions.

Ensure defects and substandard workmanship in any weld pass be removed by chipping or gouging before subsequent passes of metal are deposited. Peening or consolidating of weld metal by hammering is not permitted without the approval of the Engineer. Under conditions of very severe restraint, minimize weld cracking by acceptable techniques such as a cascade build-up sequence. Avoid any interruptions in the welding of a critical joint other than those necessary to change electrodes and quickly clean the slag from each pass before the next pass is deposited.

8. Verify the Fabricator is not creating re-entrants or local areas with high residual stresses in highly stressed parts of main members. Where beam flanges do not match well at butt welded splices, the Fabricator should deposit the weld metal in such a way as to provide a smooth transition between the parts being joined. Verify that temporary fitting aids, such as plates and angles, are not applied at highly stressed locations and that temporary tack welds are not allowed.

9. Check all members to verify the welds are of proper size and length, are being made in the proper location to conform to the approved shop drawings and are performed in such a manner as to produce weld metal conforming to the contract. To determine whether the weld metal is being deposited in such a manner as to penetrate well into the root of a joint without producing excessive slag inclusions or porosity, a field test may be conducted by making a T-joint with a fillet weld on only one side of the stem of the T. This joint can be broken open easily for visual examination. If welds are to be ground smooth and flush for any reason, verify grinding is performed so grinding marks are not left transverse to the direction of the main stress in a member. Verify welds are not being over ground resulting in a "dished" surface. Verify the ends of welds are being ground smooth after runoff tabs are removed.

10. Ensure the Fabricator identifies with paint (and does not steel stamp) each splice of main member with the symbol of the welder doing the work. If two welders work on such a splice, verify the symbol of each and record, in writing, the work each welder performed.

11. Record progress of fabrication on MDOT Form 0538. Include the dates that the work was completed and pertinent remarks regarding problems encountered and corrective action taken.

2.3.4.5 After Welding

1. Verify welds are cleaned of slag and weld spatter so they can be given a thorough final examination. Verify the surfaces of the welds are reasonably smooth and of suitable contour without evidence of undercut, overlap, excessive convexity, insufficient throat or leg size, unfilled craters at the ends of welds, or other defects in excess of the limits prescribed by the contract. Refer to the contract for the appearance of welds containing these various kinds of defects. Ensure all scars and defects, such as undercutting or remnant portions of tack welds and other scars that are left after the removal of temporary fitting and erection clips are corrected to be within the tolerances specified.

2. Check the storage, loading, blocking, and handling of the welded members to avoid distortion or structural damage. Verify braces or lugs are not welded to the members.

3. Verify the final camber and required curvature (or sweep) of all girders after all fabrication steps have been completed by observing QC perform their inspection. The Engineer will notify the QAI if they are required to perform QA inspection using the appropriate MDOT forms. Any members that measure out of tolerance must be noted for corrective action and

rechecked after the correction has been made.

2.3.4.6 Non-Destructive Testing (NDT)

Also known as non-destructive examination (NDE), NDT is the responsibility of the Fabricator per the contract. QAI verifies the NDT requirements of the contract are correctly performed and documented. Knowledge of the principles and procedures of NDT is essential for QAI to verify QC during NDT.

Ensure the required testing is performed and documented as required in the contract. Verify that the weld surface and adjacent plate surfaces are in satisfactory condition prior to non-destructive testing (NDT).

Verify NDT QCIs are ASNT Level II or III or otherwise qualified as required by the applicable welding code by reviewing certification records.

Check the performance of NDT QCIs at frequent intervals to verify approved procedures are being used, all weld joints to be tested are examined in accordance with contract and results are recorded. QAI should witness NDT of all critical splices. Collect all NDT reports generated and submit to the Engineer with the final documentation package.

Verify QC identifies locations of all rejected welds. Observe the excavation of defects and the use of MT inspection to verify no part of the defect remains. Verify that the Fabricator follows all approved weld repair plans.

Perform VT after blast-cleaning the base metal for weld surface defects, weld finish, and edge and hole finish requirements.

A. NDT Inspection Methods

Typically, the inspection methods acceptable for MDOT work are:

a. Visual testing (VT) inspection

b. Penetrant testing (PT) inspection

c. Magnetic particle testing (MT) inspection

d. Ultrasonic testing (UT) inspection

e. Radiographic testing (RT) inspection

See the contract documents for unique and alternate NDT methods and requirements.

B. Interpretation

The interpretation of all NDT is the responsibility of the Fabricator's QC personnel. QAI is responsible for reviewing all the Fabricator's interpretations and calling any disagreements to the attention of the Engineer. The Engineer's interpretation is final, and they may also call for additional testing to further explore a discrepancy.

2.3.4.7 Inspection of Shop Cleaning and Coating Fabricated Steel

QAI is responsible for verifying that QC is being effective and enforcing all cleaning and coating contract requirements. All MDOT steel bridge contracts specify a high technology coating system. Most steel bridges are completely shop coated (i.e., primer, intermediate, and topcoat) by the Fabricator. The essential phases of inspecting a coating system are summarized below:

1. Environmental Conditions

The contract includes specific controls on environmental conditions (e.g., temperature, humidity, cleanliness, air movement, shading, etc.). These conditions must be strictly enforced.

2. Coating Materials

All paints must be carefully mixed, thinned, and handled in accordance with the manufacturer's specifications. Verify QC is recording all batch numbers used for comparison to the certification documents. Verify the color numbers of the topcoat for conformance to the approved shop drawings. Verify all materials do not exceed the required expiration date.

3. Cleaning and Coating Equipment

High technology coating systems employ the most sophisticated blast cleaning and spray painting equipment developed. A thorough knowledge of their operation and use is required by the QAI. QAI is responsible for evaluating the performance of the equipment prior to the coating of the structural steel. If any of the equipment is operating outside of the specification limits the coatings will not be properly applied and may fail (peeling) at some time after application.

4. Steel Surface Conditions

All grinding, weld repairs, and fabrication steps must be completed before blast cleaning and painting. Any remedial work performed after coating may be grounds for rejection of the coating system. The steel must be free of all traces of grease and oil before blast cleaning is performed.

5. Surface Preparation

Verify QC is monitoring surface cleanliness and surface profile using specialized equipment per the contract.

6. Coating Application

QAI must verify that the proper techniques of applying the high technology coating systems is being performed. Improper application techniques may "appear" to give acceptable results but will lead to a greatly reduced performance life and possibly an early coating failure (blistering and peeling). QAI must verify QC is monitoring all environmental conditions before and during the coating process. Corrective actions must be taken on each coat of the painting system before the next coat is applied. Ensure that approved coating repair procedures are followed.

7. Documentation

Documentation of an approved coating on structural steel consists of the QC test reports on the coating evaluations and environmental conditions as well as a certificate of compliance from the paint manufacturer. MDOT coating systems are in a Qualified Products List found in the MDOT MSG. The certificate of compliance attests that the painting materials supplied are the same as those submitted to MDOT for acceptance testing.

8. Handling, Storage, and Repair

QAI must verify all contract for handling, storage, and repair of shop painted steel are strictly followed. All paint damages during handling and loading by the Fabricator must be repaired using approved procedures prior to QAI's approval for shipping.

2.3.5 Reports

A. The Engineer may require a periodic status report from the SFU; therefore, all reports are required to be completed in a timely and orderly manner using the applicable forms listed below that can be found on MDOT's website. Make entries as soon as possible after an event or conversation to ensure accuracy. Number the reports consecutively until completion of the work with the last report noted "final".

B. QAI must complete an accurate and detailed account of fabrication for the project. The report must include a discussion of fabrication progress for all aspects of the work. It is intended to be a detailed record of the status of fabrication and should include number of products fabricated, documentation of specification and procedure compliance as well as documentation of conflicts, repairs, and other problems or discussion which could affect the project in any way. If force account work is taking place, document each day that the work occurs in the shop and which products are being worked on.

C. Documentation is not a substitute for appropriate dialogue with the Fabricator but should provide a record of important discussions. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the SFU's correspondence.

D. Reports must be assembled into one fabrication inspection portable document format (PDF) file and stored in MDOT's ProjectWise document storage program per *MDOT's SFU's E-Construction Process*. The Engineer will receive a fabrication inspection memorandum from the Structural Fabrication Engineer after fabrication inspection is complete. The memorandum is for informational purposes and is not used for acceptance.

E. Below is a list of various MDOT reports/forms and a brief description of their purpose and use requirement. Similar forms can be used in place of the standard MDOT form if noted below.

1. *Project Folder Checklist (Form 1942)* – This form must be completed by QAI for each project. The checklist is placed on top of the fabrication inspection file when the project is complete.

2. *Shop Inspection Report (Form 5617)* – This form (or the consultant's company form) must be completed by QAI on a weekly basis for each project and should contain a brief narrative of the work performed over the reporting period and include photos when necessary while omitting emotions and personal feelings. Refer to the Narrative Report Writing section earlier in this document for requirements.

3. *Mill Certification Record (Form 0538D)* – This form is completed by the QAI during the fabrication of a bridge. An entry is made for each girder in the bridge and the actual mill certification heat numbers for every plate used in fabricating the girder are recorded in an orderly sequence (including beams, cover-plates, webs, flanges, splice plates, etc.). A notation is made when the corresponding mill certification has been received and checked by the QAI.

4. *Sample Identification (Form 1923)* – This form must be submitted to the MDOT Metals Lab along with the sample when material sampling is required on a project. QAI must completely fill out the form and keep a copy in the fabrication inspection file.

5. *Welder Qualification Field Data Report (Form 1929)* – This form is submitted with each test of a welder, welding operator, or welding procedure when weld testing is required. All the available parameters requested on the form must be completed since the approvals issued from these tests are conditional for the variables tested.

2.3.6 Stockpile Payment

This stockpile payment section directs the QAI on the requirements when stockpile payment inspection is requested by the SFU. The QAI must perform the following steps:

1. Verify plate/rolled material is traceable to the mill certifications and meets ASTM A6 (if applicable).
2. Verify fabricated material meets approved shop drawings (if applicable).
3. Verify stockpile quantity and include quantity in report.
4. Verify material is labeled for MDOT use only.
5. Verify material is correctly stored and protected from the weather; and
6. Provide a report summarizing the inspection and provide adequate photos that represent the general condition of the products, how they are being stored, mill markings or piece marks, and mill certifications for plate/rolled material if applicable.

2.3.7 Acceptance

A. Bill of Lading

The Fabricator is required to provide the QAI with a minimum of five (5) copies of the Bill of Lading for each shipment. QAI will stamp each copy of the Bill of Lading with the MDOT "Approved for Use" stamp and will retain one copy for their records. It is the Fabricator's responsibility to distribute the remaining copies of Bill of Lading to the following individuals:

1. Engineer
2. Contractor
3. Trucking company

The Bill of Lading is required to contain, at a minimum, the following information:

1. Shipping date
2. Description of cargo (quantity, product size, weight, etc.)
3. Product unique piece mark
4. MDOT project location (route, crossroad/river, and city)
5. MDOT project information (structure number, control section, and job number)
6. Manufacturer's name and address

B. Acceptance Process

Acceptance consists of the following two-part process:

1. Fabrication Inspection Acceptance: Structural products must be inspected by the QAI after they are loaded for shipping. If the structural products meet the contract requirements, the QAI will stamp them "Approved for Use". All main members must be stamped "Approved for Use" prior to shipping; some secondary and miscellaneous components will not be individually stamped. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for use by the Department and does not relieve the Contractor of their responsibility to meet contract requirements.
2. Visual Inspection (VI) Acceptance: The Engineer must collect one copy of the stamped Bill of Lading and use it to verify the delivered structural products. Additionally, the Engineer must verify that the products are stamped and visually inspect them for signs of damage that may have occurred as a result of shipping and handling. This visual inspection should

be documented in the field inspector's daily report.

2.4 Lighting, Signal, And Sign Support Structure Fabrication

2.4.1 Scope

This lighting, signal, and sign support structure fabrication inspection procedure should be used to aid the QAI in interpreting and enforcing the contract for highway structures. Fabrication inspection includes the time from verifying materials used for fabrication through loading for shipping to the construction site. The following lighting, signal, and sign support structures are inspected using this procedure:

1. Traffic sign support structures:
    a. Cantilever
    b. Truss
    c. Dynamic message sign
    d. Bridge sign connections
    e. Steel column breakaway
2. Tower lighting unit
3. Traffic signal mast arm pole and mast arm

2.4.2 Reference Documents

A. QAI must have a thorough knowledge of the following references:

1. The applicable sections of the *MDOT Standard Specifications for Construction (MDOT SSC)* as modified by *Supplemental Specification 12SS-001A – Errata*.
2. The following *Frequently Used Special Provisions (FUSP)*, as applicable:

12SP-105A	Source of Steel and Iron (Buy America)
12SP-707A	Special Provision for Structural Steel and Aluminum Construction
12SP-707F	Special Provision for Structural Steel Construction Revisions
12SP-716B	Special Provision for Coating of Galvanized Lighting, Signal, Sign, and Miscellaneous Support Structures
12SP-810C	Special Provision for Traffic Signal Mast Arm Pole and Mast Arm
12SP-810D	Special Provision for Mast Arm Pole Foundation and Anchor Bolts

3. *Structural Steel QAI Manual*
4. AWS D1.1, Structural Welding Code – Steel (as modified by 12SP-707A, Structural Steel and

Aluminum Construction), hereafter called AWS D1.1

5. *MDOT Materials Source Guide (MSG)*
6. Prefabrication meeting minutes (if available)

B. QAI must be familiar with the following references:

1. AWS 2.4, Symbols for Welding and Nondestructive Testing
2. AWS A3.0, Standard Welding Terms and Definitions
3. *MDOT Structural Fabrication Request for Information Process*
4. *MDOT Structural Fabrication Nonconformance Process*
5. Applicable SSPC specifications
6. Applicable coating test methods
7. Applicable ASTM and AASHTO specifications
8. MDOT Accident Prevention Plan

2.4.3 Qualifications, Responsibilities, Duties, and Equipment

2.4.3.1 Qualifications of the QAI

QAI performing the fabrication inspection must possess an active AWS Certified Welding Inspector (CWI) certification.

2.4.3.2 Responsibilities of the QAI

QAI performing the fabrication inspection is not permitted to make changes to the contract and has the following responsibilities:

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction. QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection to produce a product satisfying the contract. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

QAI is the responsible party, representing the Engineer, who performs quality assurance verification inspection on the product after QC inspects and approves the item of work. The QAI must provide inspection during fabrication as directed by the Engineer and must perform each inspection item shown in section 2.4.4.3 thru 2.4.4.8 below a minimum of once per project or per the project ITP whichever is more frequent. If issues arise, it will be at the Engineer's discretion whether to increase the level of QA inspection.

It is the Engineer's responsibility to engage the EOR when making structural decisions. The Engineer is also responsible for following internal MDOT procedures for review and approval of shop drawings, fabrication procedures, RFIs, NCRs, and for professional decision making on fabrication problems that arise. The Engineer relies on the SFU to manage and assist when appropriate. The Engineer has the prerogative for holding a prefabrication meeting with the Fabricator to discuss and clarify the contract plans and specifications. The Engineer is the responsible party who ensures MDOT's fabrication QA program is followed for inspection and acceptance of the product.

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the SFU is aware of this activity and await instruction on how to proceed. If the Engineer permits the work to proceed without approved shop drawings, proceed with basic QA functions using the non-approved shop drawings. Later, verify notes against approved drawings. Notify the SFU immediately if fabrication is not in conformance with the approved shop drawings.

2.4.3.3 Duties of the QAI

QAI performing the fabrication inspection has the following duties:

1. QAI must thoroughly understand the contract.
2. QAI must verify steel material certifications show compliance with Buy America contract requirements.
3. QAI must be proficient in testing welders, sampling materials, verifying material traceability, and inspecting welds and coating systems.
4. QAI must be proficient in writing reports and using computers.
5. QAI must notify the Engineer if production begins before approved shop drawings are on the shop floor and provided to the QAI.
6. QAI must communicate all concerns through QCI or whomever the Fabricator directs during the prefabrication meeting.
7. QAI must communicate with QCI to obtain the work schedule.
8. QAI must follow *MDOT's Structural Fabrication E-Construction Process* for closing out fabrication inspection file.

2.4.3.4 Deficiencies on Local Agency Projects

MDOT's QAI must notify the SFU if they observe fabrication or inspection deficiencies on local agency program (LAP) projects. The Structural Fabrication Engineer will report the deficiencies via email to the Engineer that is responsible for construction oversight of the local agency project and carbon copy the applicable CFS and Design Division LAP Engineers.

2.4.3.5 Inspection Facilities and Access

Facilities for the QAI must be provided by the Fabricator per contract. QAI must always have access to all parts of the work . The authority and general duties of the QAI are specified in Section 104.01.D and E of the MDOT SSC.

2.4.3.6 Inspection Equipment

QAI will be furnished with the following items by the Engineer:

1. Contract (MDOT SSC, special provisions, standard plans, special details, plan sheets, etc.)
2. Approved shop drawings (provided by Fabricator)
3. MDOT shop approval stamp
4. Numbered plastic sample tags and sampled adhesive tags for material sampling
5. Plastic bags for sampling high strength bolts

QAI must provide the following inspection equipment:

1. Computer with high speed internet access
2. Cell phone
3. Digital camera (can be integral with cell phone)
4. Flashlight
5. Fillet weld gauges
6. Undercut gauges
7. Instrumentation for measuring voltage and amperage
8. Temperature measuring devices capable of covering the range from 0°F to 1650°F
9. Dry film thickness gauges
10. Wet film paint thickness gauge
11. Surface roughness comparator gage
12. Extra course replica tape for measuring blasted steel surface profile
13. SSPC book of pictorial blast standards
14. Temperature and humidity measuring instruments
15. Measuring devices (200 foot and 20-foot steel tape and calipers)
16. Straightedge and levels
17. Safety equipment
18. Other as needed for the project

2.4.4 Inspection Procedure

2.4.4.1 Prefabrication Meeting

Prefabrication meetings facilitate effective quality control and quality assurance on the project and are conducted by the SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must be present, whereas the Engineer and Contractor should be present to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective communication.

2.4.4.2 Inspection Overview

Structural steel must be fabricated in accordance with the MDOT SSC and contract. Fabrication inspection is performed in accordance with the ITP specified in the MDOT work assignment and as shown below:

1. Structural steel fabrication inspection consists of verifying compliance with the approved shop drawings, contract, and approved NCRs. RFIs must be incorporated into the approved shop drawings for the QAI to inspect to.
2. An approved Materials Source List (MSL), submitted by the Fabricator to the MDOT Structural Fabrication Unit and the Engineer for review and approval, may be provided to the QAI. The QAI reviews what materials are being incorporated into the project and documents the basis of acceptance for each material. The MSL is used to track material sampling by the QAI and to foster communication with QC to ensure all required sampling and testing

occurs in a timely manner to prevent impacts to the project schedule. Structural steel projects typically only include high strength and anchor bolt materials; however, since this material is shown in the approved shop drawings an MSL is not required. The MSL does prove to be very useful for complex projects and may be required by the Engineer. It is the Fabricator's responsibility to notify the QAI when materials are available for sampling.

3. QAI begins by inspecting materials that will be used in the fabrication process and ensures they are being stored correctly, tagged for traceability purposes, and are in conformance with the contract. Next, the QAI inspects the Fabricator's operations to ensure the condition of the equipment and work area for conformance to the contract.

4. MDOT's Accident Prevention Plan states, "MDOT employees shall not engage in any act which would endanger another employee or themselves". QAI must notify the Engineer immediately if work conditions exist that are not safe. If the level of inspection diminishes below what is specified in this QA procedure, due to safety concerns, then the product will not be approved for use.

2.4.4.3 Fabrication Inspection

Cantilever sign support, tower lighting unit, and traffic signal mast arm pole and mast arm structures must be fabricated in accordance with the MDOT SSC and contract. Welders must be qualified in accordance with MDOT's Welder Qualification Program prior to welding on structures. Visually inspect flanges using a straight edge for flatness to assure that full contact of flanges is obtained in an unbolted relaxed condition. Inspect structural products for straightness, flange bolt hole alignment, and horizontal truss member camber per the contract. Truss Sign Supports Only – Witness the bolting and vertical horizontal truss sections to ensure proper alignment and bolt tightening procedures (truss sign supports only) per the MDOT SSC.

2.4.4.4 Before Welding

Below is a checklist for the QAI to use for fabrication inspection prior to the start of welding. The actual steps and their exact sequence will depend upon the type of structure, the method of erection, and the qualifications of the welders who are to do the work.

1. Verify mill test reports match the base metal for conformance with the specifications. Verify that QC is maintaining traceability of all materials to such degree that the heat number of each piece of steel that is used in the project can be tracked to its location in the structure. Obtain from the Fabricator, if necessary, the shipping records, storage locations, and scheduling for each piece of steel that they intend to use in connection with the assigned contract. Examine each piece of steel as it is received at the shop to see that it has no uncorrected defects, kinks, or bends resulting from improper handling while in the mill or shop or in transit from mill to shop. Verify that the material from the mill meets ASTM A6.

2. Verify all welders are MDOT qualified (see *MDOT's Welder Qualification Program*) and have appropriate fracture critical qualification, if applicable. Require requalification or supplementary welder tests if there are concerns. MDOT's SSC requires that all tack welders, welders, and welding operators are current MDOT qualified welders for the welding process, plate thickness, and position prior to welding.

3. Verify that the WPS and welding sequences are agreed to and understood by QAI, QC, and Fabricator prior to welding. All WPSs and PQRs are required to be reviewed and approved by the SFU. The Contract requires all WPSs to be qualified as required in the related welding code prior to welding. This qualification requirement is inclusive of all types of welds (butt welding, fillet welding, seal welding, plug welding, etc.). MDOT will accept prequalified WPSs if they meet all the requirements of the code for prequalification. MDOT also accepts properly documented evidence of previous PQRs that have not expired. See the contract for specific WPS and PQR requirements. The Fabricator is required to post

approved WPS's at each welding station.

4. Make a general examination of the structural steel and verify the quality of fabrication. Pay attention to the plate edge preparation, which would affect control over welding. Notify QC of any observed deficiencies before weld joint fit up is complete so they can correct any deficiencies.

5. Check the fitting of joints that are to be welded, including dimensions of root face, angle of bevel, cleanliness, match marks, alignment of parts to be joined, and uniformity and size of root openings. Recheck root faces and angles of bevel because trimming and re-beveling of plate edges is sometimes performed during fitting. Check the prepared weld joint edges for evidence of possible undesirable internal defects such as laminations in the steel plate. Make dimensional checks of all critical measurements to assure a proper fit in the field.

6. Check the fixture, clamping, and pre-cambering arrangements used in the fabrication assembly setup for adequacy. Make certain tack welds are made by MDOT qualified welders and the welds are small, smooth, and of specified quality. Verify that runoff tabs or extension plates are in place to ensure complete welding beyond the plate edges.

2.4.4.5 During Welding

1. Verify all welding is being performed using the approved WPS and sequences (if applicable) and electrodes are used with suitable currents and polarity for the positions the electrodes are intended to be used. Refer to the approved WPS for all details of performing the weld in question.

2. During inclement weather, ensure that suitable windbreaks or shields are provided, and welding is not performed on surfaces that are wet, exposed to rain or snow, or if a heavy fog is present. Check the ambient and steel temperatures at the start of welding and during welding to determine if the specified preheat and interpass temperature requirements are being observed. Use temperature-indicating crayons or other equivalent means to check these temperatures.

3. Check to make certain the correct electrodes (type and size) are available and are properly dried to prevent porosity and hydrogen cracking in the final welds. Low-hydrogen electrodes are susceptible to these types of defects if they are exposed to the atmosphere beyond the recommended limits. If electrodes and fluxes have been improperly stored or exposed to humidity in excess of the recommended limits, notify QC that reconditioning, or rejection is required per the contract.

4. Intermittently observe the technique and performance of each welder to verify the approved WPS and suitable techniques are being followed. Inspect important or unique joints multiple times to ensure all weld passes meet project specifications. Arrange for the welder or the foreman to notify the QAI when such inspections at various stages may be made. Report any unusual or excessive distortion during welding to QC. Verify all corrective measures are being followed as approved by the Engineer to ensure the Fabricator's methods minimize locked-in stresses.

5. Verify the welding arc is only struck in the joint or other area on which metal is to be deposited and not at random locations on the base metal outside of the prepared joint. Arc strikes cause physical and metallurgical stress risers and can change the mechanical properties of the steel at isolated locations. These changes can result in fatigue failures. Verify that approval by the Engineer has been given to the Fabricator prior to ground bars, clips, or ties being welded to the base metal. Approval for such welding is only given by the Engineer when unavoidable. When steel ground bars are used instead of ground clamps to carry the welding current to the base metal, make certain the ground bars are carefully welded to the base metal at a runoff tab or securely clamped to any area where all mill

scale has been removed. Verify the grounding lead is as close to the point of welding as is practical.

6. Inspect root passes with special care because it is very important the first weld materials deposited in the root of a multiple pass weld is properly performed. Closely examine the root pass in important complete joint penetration welds, such as pole to base plate and splices to verify a sound pass that is free from cracks, inclusions, and lack of fusion.

7. Verify the root pass and every subsequent weld pass is cleaned with a wire brush and chipping hammer to thoroughly remove slag between weld passes to avoid inclusions. Ensure defects and substandard workmanship in any weld pass be removed by chipping or gouging before subsequent passes of metal are deposited. Peening or consolidating of weld metal by hammering is not permitted without the approval of the Engineer. Under conditions of very severe restraint, minimize weld cracking by acceptable techniques such as a cascade build-up sequence. Avoid any interruptions in the welding of a critical joint other than those necessary to change electrodes and quickly clean the slag from each pass before the next pass is deposited.

8. Verify the Fabricator is not creating re-entrants or local areas with high residual stresses in highly stressed parts of primary members. Verify that temporary fitting aids, such as plates and angles, are not applied at highly stressed locations and that temporary tack welds are not allowed.

9. Check all members to verify the welds are of proper size and length, are being made in the proper location to conform to the approved shop drawings and are performed in such a manner as to produce weld metal conforming to the contract. To determine whether the weld metal is being deposited in such a manner as to penetrate well into the root of a joint without producing excessive slag inclusions or porosity, a field test may be conducted by making a T-joint with a fillet weld on only one side of the stem of the T. This joint can be broken open easily for visual examination. If welds are to be ground smooth and flush for any reason, verify grinding is performed so grinding marks are not left transverse to the direction of the main stress in a member. Verify welds are not being over ground resulting in a "dished" surface. Verify the ends of welds are being ground smooth after runoff tabs are removed.

10. Ensure the Fabricator identifies with paint (do not steel stamp) each splice with the symbol of the welder doing the work. If two welders work on such a splice, verify the symbol of each and record, in writing, the work each welder performed.

11. Record progress of fabrication on MDOT Form 0538. Include the dates that the work was completed and pertinent remarks regarding problems encountered and corrective action taken.

2.4.4.6 After Welding

1. Verify welds are cleaned of slag and weld spatter so they can be given a thorough final examination. Verify the surfaces of the welds are reasonably smooth and of suitable contour without evidence of undercut, overlap, excessive convexity, insufficient throat or leg size, unfilled craters at the ends of welds, or other defects in excess of the limits prescribed by the contract. Refer to the contract for the appearance of welds containing these various kinds of defects. Ensure all scars and defects, such as undercutting or remnant portions of tack welds and other scars that are left after the removal of temporary fitting and erection clips are corrected to be within the tolerances specified.

2. Check the storage, loading, blocking, and handling of the welded members to avoid

distortion or structural damage. Verify braces or lugs are not welded to the members.

3. Verify the final camber and required curvature (or sweep) of all members after all fabrication steps have been completed by observing QC perform their inspection. The Engineer will notify the QAI if they are required to perform QA inspection using the appropriate MDOT forms. Any members that measure out of tolerance must be noted for corrective action and rechecked after the correction has been made.

2.4.4.7 Non-Destructive Testing (NDT)

Also known as non-destructive examination (NDE), NDT Is the responsibility of the Fabricator per the contract. QAI verifies the NDT requirements of the contract are correctly performed and documented. Knowledge of the principles and procedures of NDT is essential for QAI to verify QC during NDT.

Ensure the required testing is performed and documented as required in the contract. Verify that the weld surface and adjacent plate surfaces are in satisfactory condition prior to non-destructive testing (NDT).

Verify NDT QCIs are ASNT Level II or III or otherwise qualified by reviewing certification records.

Check the performance of NDT QCIs at frequent intervals to verify approved procedures are being used, all weld joints to be tested are examined in accordance with contract and results are recorded. QAI should witness NDT of all critical splices and pole to base connection. Collect all NDT reports generated and submit to the Engineer with the final documentation package.

Verify QC identifies locations of all rejected welds. Observe the excavation of defects and the use of MT inspection to verify no part of the defect remains. Verify that the Fabricator follows all approved weld repair plans.

Perform VT after blast-cleaning the base metal for weld surface defects, weld finish, and edge and hole finish requirements.

Refer to Section 2.3.5 above for suggested radiographic testing procedure if used.

A. NDT Inspection Methods

Typically, the inspection methods acceptable for MDOT work are:

a. Visual testing (VT) inspection of weldments must be in accordance with the contract.

b. Penetrant testing (PT) inspection of weldments must be in accordance with the contract.

c. Magnetic particle testing (MT) inspection of weldments must be in accordance with the contract.

d. Ultrasonic testing (UT) inspection of weldments must be in accordance with the contract.

e. Radiographic testing (RT) inspection of weldments must be in accordance with the contract.

See the contract documents for unique and alternate NDT methods and requirements.

B. Interpretation

The interpretation of all NDT is the responsibility of the Fabricator's QC personnel. QAI is responsible for reviewing all the Fabricator's interpretations and calling any disagreements to the attention of the Engineer. The Engineer's interpretation is final, and they may also call for additional testing to further explore a discrepancy.

2.4.4.8 Inspection of Shop Cleaning and Coating Fabricated Steel

QAI is responsible for verifying that QC is being effective and enforcing all cleaning and coating contract requirements.

A. Hot-dip Galvanizing

All MDOT structures require hot-dip galvanizing (HDG) and may be coated using a high technology wet coating system or dry system per the contract. HDG must be inspected by the Fabricator and verified (spot-checked) by the QAI for conformance to the applicable ASTM and contract. Unless specified in the contract documents or in the MDOT Work Assignment, QAI verification includes:

1. Material Preparation by the Fabricator

Structural members are detailed and fabricated with drainage and venting provisions. Pre-galvanizing surface preparation is completed per project requirements. Welds are blast-cleaned when required. Members are identified with metal tags or other means and methods agreed upon by both the Fabricator and the galvanizer. Instructions to the galvanizer are documented and include project-specific requirements.

2. Receipt Inspection after Galvanizing (when applicable)

Documentation by the galvanizer is complete including inspection records. Member identification is maintained. Visual inspection and spot checks of the coating integrity are performed by the Fabricator. Repairs, if required, are completed per project requirements. Other related nonconformance such as damage or distortion is identified and resolved.

B. Painting Over Galvanizing

The essential phases of inspecting are summarized below:

1. Environmental Conditions

Contract includes specific controls on environmental conditions (e.g., temperature, humidity, cleanliness, air movement, shading, etc.). These conditions must be strictly enforced.

2. Coating Materials

All paints must be carefully mixed, thinned, and handled in accordance with the manufacturer's specifications. Verify QC is recording all batch numbers used for comparison to the certification documents. Verify the color numbers of the topcoat for conformance to the approved shop drawings. Verify all materials do not exceed the required expiration date.

3. Cleaning and Coating Equipment

High technology coating systems employ the most sophisticated blast cleaning and spray painting equipment developed. A thorough knowledge of their operation and use is required by the QAI. QAI is responsible for evaluating the performance of the equipment prior to the coating of the structural steel. If any of the equipment is operating outside of the specification limits the coatings will not be properly applied and may fail (peeling) at some time after application.

4. Steel Surface Conditions

Surfaces are prepared for coating including any solvent or blast cleaning. The steel must be free of all traces of grease and oil before blast cleaning is performed.

All grinding, weld repairs, and fabrication steps were completed before galvanizing. Any remedial work performed after coating may be grounds for rejection of the coating system.

5. Surface Preparation

Verify QC is monitoring surface cleanliness and surface profile using specialized equipment per the contract.

Smoothing, cleaning, and profiling of galvanized surfaces conforms to project requirements. These requirements include ASTM D6386 Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting and referenced SSPC SP16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel.

6. Coating Application

QAI must verify that the proper techniques of applying the high technology coating systems are being performed. Improper application techniques may "appear" to give acceptable results but will lead to a greatly reduced performance life and possibly an early coating failure (blistering and peeling). QAI must verify QC is monitoring all environmental conditions before and during the coating process. Corrective actions must be taken on each coat of the painting system before the next coat is applied. Ensure that approved coating repair procedures are followed.

7. Documentation

Documentation of an approved coating on structural steel consists of the QC test reports on the coating evaluations and environmental conditions as well as a certificate of compliance from the paint manufacturer. MDOT coating systems are in a Qualified Products List found in the MDOT MSG. The certificate of compliance attests that the painting materials supplied are the same as those submitted to MDOT for acceptance testing.

8. Handling, Storage, and Repair

QAI must verify all contract for handling, storage, and repair of shop painted steel are strictly followed. All paint damages during handling and loading by the Fabricator must be repaired using approved procedures prior to QAI's approval for shipping.

2.4.5 Reports

A. The Engineer may require a periodic status report from the SFU; therefore, all reports are required to be completed in a timely and orderly manner using the applicable forms listed below that can be found on MDOT's website. Make entries as soon as possible after an event or conversation to ensure accuracy. Number the reports consecutively until completion of the work with the last report noted "final".

B. QAI must complete an accurate and detailed account of fabrication for the project. The report must include a discussion of fabrication progress for all aspects of the work. It is intended to be a detailed record of the status of fabrication and should include number of products fabricated, documentation of specification and procedure compliance as well as documentation of conflicts, repairs, and other problems or discussion which could affect the project in any way. If force account work is taking place, document each day that the work occurs in the shop and which products are being worked.

C. Documentation is not a substitute for appropriate dialogue with the Fabricator but should provide a record of important discussions. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the SFU's correspondence.

D. Reports must be assembled into one fabrication inspection portable document format (PDF) file and stored in MDOT's ProjectWise document storage program per MDOT's SFU's E-Construction Process. The Engineer will receive a fabrication inspection memorandum from the Structural

Fabrication Engineer after fabrication inspection is complete. The memorandum is for informational purposes and is not used for acceptance.

E. Below is a list of various MDOT reports/forms and a brief description of their purpose and use requirement. Similar forms can be used in place of the standard MDOT form if noted below.

1. *Project Folder Checklist (Form 1942)* – This form must be completed by QAI for each project. The checklist is placed on top of the fabrication inspection file when the project is complete.

2. *Shop Inspection Report (Form 5617)* – This form (or the consultant's company form) must be completed by QAI on a weekly basis for each project and should contain a brief narrative of the work performed over the reporting period and include photos when necessary while omitting emotions and personal feelings. Refer to the Narrative Report Writing section earlier in this document for requirements.

3. *Sample Identification (Form 1923)* – This form must be submitted to the MDOT Metals Lab along with the sample when material sampling is required on a project. QAI must completely fill out the form and keep a copy in the fabrication inspection file.

4. *Welder Qualification Field Data Report (Form 1929)* – This form is submitted with each test of a welder, welding operator, or welding procedure when weld testing is required. All the available parameters requested on the form must be completed since the approvals issued from these tests are conditional for the variables tested.

2.4.6 Stockpile Payment

This stockpile payment section directs the QAI on the requirements when stockpile payment inspection is requested by the SFU. The QAI must perform the following steps:

1. Verify plate/rolled material is traceable to the mill certifications and meets ASTM A6 (if applicable).
2. Verify fabricated material meets approved shop drawings (if applicable).
3. Verify stockpile quantity and include quantity in report.
4. Verify material is labeled for MDOT use only.
5. Verify material is correctly stored and protected from the weather; and
6. Provide a report summarizing the inspection and provide adequate photos that represent the general condition of the products, how they are being stored, mill markings or piece marks, and mill certifications for plate/rolled material if applicable.

2.4.7 Acceptance

A. Bill of Lading

The Fabricator is required to provide the QAI with a minimum of five (5) copies of the Bill of Lading for each shipment. QAI will stamp each copy of the Bill of Lading with the MDOT "Approved for Use" stamp and will retain one copy for their records. It is the Fabricator's responsibility to distribute the remaining copies of Bill of Lading to the following individuals:

1. Engineer
2. Contractor
3. Trucking company

The Bill of Lading is required to contain, at a minimum, the following information:

1. Shipping date
2. Description of cargo (quantity, product size, weight, etc.)
3. Product unique piece mark
4. MDOT project location (route, crossroad/river, and city)
5. MDOT project information (structure number, control section, and job number)
6. Manufacturer's name and address

B. Acceptance Process

Acceptance consists of the following two-part process:

1. Fabrication Inspection Acceptance: Structural products must be inspected by the QAI after they are loaded for shipping. If the structural products meet the contract requirements, the QAI will stamp them "Approved for Use". All main members must be stamped "Approved for Use" prior to shipping; some ancillary and miscellaneous components will not be individually stamped. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for use by the Department and does not relieve the Contractor of their responsibility to meet contract requirements.
2. Visual Inspection (VI) Acceptance: The Engineer must collect one copy of the stamped Bill of Lading and use it to verify the delivered structural products. Additionally, the Engineer must verify that the products are stamped and visually inspect them for signs of damage that may have occurred as a result of shipping and handling. This visual inspection should be documented in the field inspector's daily report.

3 Inspection and Test Plans

MDOT has developed several standard inspection and test plans (ITPs) to support the fabrication inspection procedures provided in Chapter 2 by providing the QAI with a specific plan. QAI activities are listed along with their referenced requirements, activity codes, frequency, basic description, and output/record. Detailed descriptions of these activities are found in the fabrication inspection procedures.

3.1 Hold Points

Some QAI activities are identified as hold points. These are sensitive steps that require QAI notification by the Fabricator. Fabrication must not proceed past these points until the QAI is either satisfied of the outcome through direct testing or observation of QC testing, or the QAI grants a waiver of the hold point based on situational evaluation. QAI satisfaction or waiver does not constitute product acceptance, which is the responsibility of the Fabricator. The phrase "release hold point" means the action of communicating QAI satisfaction or waiver to the Fabricator.

3.2 Establishing and Adjusting the ITP

The Pre-Fabrication meeting minute template initially establishes the minimum number of QAI hold points which are identified as the blue shaded rows in the ITP table(s). At the start of fabrication, the QAI may recommend or request modification or addition of hold points for the approval of the MDOT Structural Fabrication Unit. Rationale for changing any aspect of a hold point (inspection criteria, frequency, or assigning hold point status to an additional activity) must be based on objective evidence and must be discussed with the MDOT Structural Precast Concrete Specialist or the MDOT Structural Steel Specialist prior to notifying the Fabricator of the new inspection requirements.

The QAI may request additional inspections, tests, or hold points during the fabrication process due to established action limits/suspension limits being exceeded or in reaction to a loss of confidence in a process. Additional inspections, tests, or hold points will be conveyed in writing to the Fabricator and must result in minimal impact to project schedule. Written conveyance must identify the duration and acceptance criteria in addition to the same level of detail as in the ITP table. MDOT Structural Fabrication Unit approval is required.

3.3 Communication Between Fabricator and QAI

Ideally, the Fabricator must convey project schedules in writing to confirm when hold point inspections will occur and that the QAI is available for the hold point inspection as requested by the Fabricator. The QAI must reply to any written requests for hold point inspections. Other forms of communication are acceptable if documented (with language clearly defining Fabricator notification to the QAI and QAI response) and agreed to at the prefabrication meeting.

The QAI is encouraged to use the ITP as a tool for communicating expectations to the Fabricator. It is intended to be reviewed at the prefabrication meetings or at any time prior to production startup. Ideally it would be reviewed side by side with the Fabricator's quality control plan or the Fabricator's own ITP to achieve continuity and reduce misunderstanding.

3.4 Standard ITPs and Inspection Levels

ITPs have been developed for three product types: structural prestressed concrete, structural non-prestressed concrete, and structural steel. The applicable ITP for a given project is communicated in the MDOT work assignment. Each of these ITPs has two versions of inspection intensity: Level I and Level II. Level I inspection is considered standard shop inspection for main load carrying members, typically requiring full-time presence by a QAI. Level II inspection is considered standard shop

inspection for auxiliary load carrying members and ancillary products, typically characterized by reduced inspection frequency and sample size. Complex and unique (e.g. aluminum, carbon fiber, etc.) projects may require a custom ITP to be developed. Below are MDOT's current standard ITPs that can be accessed by clicking the hyperlinks below or found on MDOT's SFU website:

- *Prestressed Concrete: Level I ITP*
- *Prestressed Concrete: Level II ITP*
- *Non-Prestressed Concrete: Level I ITP*
- *Non-Prestressed Concrete: Level II ITP*
- *Structural Steel: Level I ITP*
- *Structural Steel: Level II ITP*

4 Supplier Qualification Program

Supplier qualification requirements differ for each product type, but are based on the Supplier's implementation, maintenance, and auditing of its quality management system (QMS) as a key indicator of its ability to produce a quality product.

MDOT will accept products from suppliers who demonstrate a proactive QMS with procedures and processes that consistently deliver quality to the State. To assess that demonstration of quality, MDOT may rely solely on nationally recognized programs (AISC, PCI, NPCA, etc.) or may perform its own QMS Assessments when specified by project or required by an MDOT Supplier Qualification Standard (SQS).

In addition to requiring current plant certification by nationally recognized programs, project specifications may include a special Quality Management System assessment.

Alternatively, MDOT may require active adherence to a Supplier Qualification Standard (SQS) with administrative rules and specific quality management system requirements. Contractors are expected to use only those suppliers who have been identified on the MDOT Approved Supplier List as meeting this standard.

4.1 Supplier Qualification Standard for Prestressed Concrete Beams

The SQS for structural precast prestressed concrete beams, located in Appendix 3 in this manual, consists of two parts: requirements for participation (Program Rules) and minimum quality management system requirements (Standard). The Program Rules explain documentation reviews, onsite audits, achieving and maintaining qualification status, and nonconformance resolution. The Standard explains minimum MDOT requirements for a Supplier's documented QMS; the Supplier must have defined processes and documented procedures addressing all the elements in the Standard. Successful assessments to the SQS result in inclusion on the MDOT Approved Supplier List – see below for details.

4.2 Reserved for Expansion to Other Products

5 Approved Supplier List: Prestressed Concrete Beam

This section contains MDOT's Approved Supplier List (ASL). Suppliers must successfully demonstrate compliance to the related MDOT Supplier Qualification Standard to be eligible. See Chapter 4 for more information about MDOT's supplier qualification programs. MDOT's Approved Supplier List (ASL) can be accessed by clicking the related hyperlink below or found on MDOT's SFU website:

- *MDOT ASL for Prestressed Concrete Beams*

Appendices

Appendix A1: Concrete Narrative Reports

MDOT expects a minimum level of information in its QAI reports as part of its acceptance program. This section includes reporting guidelines specific to structural precast (non-prestressed or prestressed) concrete fabrication. These guidelines are in addition to the general narrative reporting requirements explained earlier in this manual; they are not all inclusive and may not be applicable to every report. Inspectors must use discretion.

Report the following information for the day, confirm acceptability, and note exceptions and deviations, as applicable. When any of the below information is recorded on a related MDOT Form and the form is completed that day, there is no need to repeat that information in the narrative report except for a reference to the related MDOT FORM report number for the reported characteristic.

a. Materials accepted: specification, material name, supplier, brand name, source location, MSL yes/no, visually accepted, inspected quantity (or percentage of total for project)

b. Facility and Equipment inspection: description of areas and equipment inspected

c. Qualified operators of equipment (stressing jacks) and certified personnel conducting stressing/elongation calculations

d. Strand packs observed in use or staged for use: IDs

e. Visual verification of aggregate gradation for potential contamination issues involving coarse aggregates, fine aggregates, or other deleterious materials. (large amounts of fine aggregate observed in the coarse aggregate or dirt other than sand observed in the fine aggregate)

f. List of piece marks/elements cast

g. Casting area, stressing bed, and anchorage used: ID

h. Steel form(s) used: element type, steel form ID(s) (if applicable)

i. Stressing jack(s) used: ID

j. Mix design used: ID (can be listed once per week)

k. Batch tickets: IDs, note any that were adjusted in transit to casting location (specifics of adjustments not required)

l. Cylinder molds made: quantity, IDs

m. Segregation controls: pouring technique (layered, staggered, etc.), consolidation methods used

n. Epoxy coated reinforcement protection: tools used, other noteworthy conditions

o. Curing controls: temperature monitoring equipment in use and status

p. Strength test cylinders broken: report only those witnessed

q. Strand release: method, control of sequence

r. List piece marks inspected post-pour: IDs

s. List piece marks inspected/released for shipment: IDs

Michigan Department
of Transportation
5617 (11/18)

FABRICATION INSPECTION REPORT

To be completed by the QA inspector and included in the final project documentation file.

REPORT # 1

GENERAL INFORMATION		
INSPECTION AGENCY ABC Inspection Agency	INSPECTOR John Doe	DATE 24 April 2020
FABRICATOR / LOCATION Prestress Girder Company		CONTROL SECTION 7598715-222540
JOB DESCRIPTION M-25 Bridge over Buck Creek	SIZE AND ELEMENT TYPE MDOT 1800 Bulb Tee Girder	JOB NUMBER 190045B
STATUS OF FABRICATION FOR PERIOD ENDING Week Ending 24 April 2020	REQUESTED DELIVERY DATE 30 June 2020	FABRICATED 5%

COMMENTS

20 April 2020

CONDITIONS
Air Temperature – 52 degrees Fahrenheit
Relative Humidity – 49%
Mostly Cloudy
Work Exposure – Work is fully exposed to elements

ACTIVITY
Travelled to Prestressed Girders' facility at Anytown USA. Arrived at the facility at 9:30AM.
I met with Joe Smith, Plant Manager, and Tom Thumb, Quality Control Manager at 10:00 AM to discuss the current schedule at the plant. Currently, the shop has all material for the first phase of the project has been received, stored per company policy and ready for production. The first phase will consist of 16 of the 32 total girders for the project.

Stranding is scheduled to begin on 22 April 2020. The shop drawings have been submitted and approved by MDOT. I requested the current calibration records and training records for the concrete testing personnel, strand tensioning staff, and PCI certifications. Tom stated that he would supply that information later today. The meeting concluded at 12:00PM.

I received the certifications from Tom Thumb and reviewed the records. All certifications are up to date. Joe Smith furnished their copy of MDOT Form 0501 (Material Source List) for the material to be used on the project. I reviewed the list for verification tomorrow.

HOURS WORKED
Travel time - 2 hours
Total time at the plant - 6 hours
Hours worked on report and form preparation - 0:30 hours
Total hours worked on MDOT project - 8 hours

21 April 2020

CONDITIONS
Air Temperature - 55 degrees Fahrenheit
Relative Humidity - 41%
Mostly Sunny
Work Exposure – Work is fully exposed to elements

ACTIVITY
I arrived at the plant at 7:30AM. The material on MDOT Form 0501 was reviewed for conformance and verified for acceptance. The following material has been reviewed for the first phase of the project.

MDOT Material Spec.	Material Item	Supplier	Brand Name	Location	MSL	Visually Inspected*	Accepted
905.07	PS Strand	InSteel Wire	N/A		Yes	Yes – 100%	Yes

902.08	2NS sand	Aggregate Industries	N/A	Edwardsburg 14-026	Yes	Yes – 100%	Yes
902.03	17A Limestone	Meshberger Brothers	N/A	Pleasant Mills 92-030	Yes	Yes – 100%	Yes
901	Type III cement	Buzzi Unicem USA	N/A	Greencastle	Yes	Yes – 100%	Yes
903.02	Type F air entrainment	GCP Applied Technologies	Terapave AEA		Yes	Yes – 100%	Yes
905.03C	Reinforcing steel(coated)	Nucor Steel – Kankakee		Bourbonnais	Yes	Yes – 50%	Yes
906	Inserts	Dayton Superior	F-42 & B-1		No	Yes – 100%	Yes
906	Sole Plates	Cardinal Fab & AZZ		AZZ-Plymouth	Yes	Yes – 50 %	Yes

* Values are approximate percentage of the total project quantities represented by the noted visual inspection.

I verbally notified Joe Smith and Tom Thumb that the inserts presented for verification were not listed on the MSL form submitted to MDOT and requested that the issue be corrected. I emailed Tom Thumb and copied Deanna Papanek with MDOT regarding the issue with the inserts and that the material hold point is released with the noted issue in accordance with the QAI ITP.
The plant began preparing Stressing Bed A1 for stranding to begin tomorrow. I inspected the side forms that will be used for the project. The forms were acceptable for use. I checked the anchorages; no unusual modifications.
I prepared independent stressing and elongation calculations.
Storage areas were in acceptable conditions. Aggregate stockpiles showed no signs of contamination or gradation issues.

HOURS WORKED
Total time at the plant -8 hours
Total time spent out in the plant - 6 hours
Hours worked on reports and calculations - 2 hours
Total hours worked on MDOT project – 8

22 April 2020

CONDITIONS
Air Temperature - 57 degrees Fahrenheit
Relative Humidity 56%
Cloudy - Light precipitation
Work Exposure – Work is fully exposed to elements

ACTIVITY
I arrived at the plant at 8:00AM. The plant had begun the stranding operation. Strand Packs 111 and 112 were in use. The strands were inspected for location and physical condition and the results were reported in MDOT Form 5616. I verified elongation calculations with Tom Thumb and verbally released the hold point requirement for tensioning readiness in accordance with the QAI ITP. The strands were tensioned to the initial stress and final stressing operations commenced, using stressing jack rig 1A. The results of the strand tensioning are listed in MDOT Form 0513.
Plant personnel commenced placing reinforcement steel and inserts. Joe Smith indicated that they plan to pour concrete at 9:00AM on 23 April 2020.
I received confirmation from MDOT that the inserts have been added to the MSL as accepted products.

HOURS WORKED
Total time at the plant – 9 hours
Total time spent out in the plant – 8 hours
Hours worked on reports – 1 hour
Total hours worked on MDOT project – 9 hours

23 April 2020

CONDITIONS
Air Temperature – 46 degrees Fahrenheit
Relative Humidity – 38%
Cloudy

Work Exposure – Work is fully exposed to elements

ACTIVITY
I arrived at the plant at 6:30 AM and verified the reinforcing steel placement, concrete cover for reinforcement, form placement and preparation, and sole plate locations, for beams A1, A2, and A3. The results of the verification are listed in MDOT Form 5616. Due to overnight temperatures, the pour was delayed for one hour. Tom Thumb and I conducted side by side fresh concrete tests. Concrete batch 1111 met the JMF properties and was accepted for placement in the forms. The results of the fresh concrete tests are reported on MDOT Form 590. I verbally released the hold point to permit placement of the concrete in accordance with the QAI ITP. Concrete strength cylinders A1-1, A1-2, and A1-3 for the release verification were identified and placed next to the forms to be cured in the same manner as the beams. Cylinders A1-4, A1-5, and A1-6 for the 28-day strength tests were taken to the testing lab, identified, and placed in the water bath curing tank.
Tom Thumb indicated that due to the weather forecast for the next few days, that strand release will be postponed, and additional steam curing will be used for the pour.
Concrete was poured in a two-layer sequence using mechanical form and handheld vibrators. The top flange was broom finished, and the steam curing operation commenced. Temperature monitors appeared functional and operating normally.
During consolidation it was observed that the handheld vibrators did not have the proper protective tips required for epoxy coated reinforcing bars used in these beams. A nonconformance report was initiated by the fabricator – ref. Fabricator NCR-001.

HOURS WORKED
Total time at the plant – 7 hours
Total time spent out in the plant – 6 hours
Hours worked on reports – 1 hour
Total hours worked on MDOT projects – 7 hours

22 April 2020

CONDITIONS
Air Temperature – 29 degrees Fahrenheit
Relative Humidity – 86%
Snowing
Work Exposure – Work is fully exposed to elements

ACTIVITY
Due to weather conditions, no work was conducted. I travelled home for the week. Tom Thumb emailed the steam curing temperatures that were recorded for the day.

HOURS WORKED
Travel time – 3 hours (weather related)
Hours worked on reports – 1 hour
Total time worked on MDOT project – 4 hours

Appendix A2: Steel Narrative Reports

MDOT expects a minimum level of information in its QAI reports as part of its acceptance program. This section includes reporting guidelines specific to structural steel fabrication. These guidelines are in addition to the general narrative reporting requirements explained earlier in this manual; they are not all inclusive and may not be applicable to every report. Inspectors must use discretion.

Report the following information for the day, confirm acceptability, and note any exceptions or deviations, as applicable. When any of the below information is recorded on a related MDOT Form and the form is completed that day, there is no need to repeat that information in the narrative report except for a reference to the related MDOT FORM report number for the reported characteristic.

a. Materials accepted: MDOT specification number, material description, supplier, material specification and grade, source location, MSL yes/no, visually accepted, inspected quantity (or percentage of total for project)

b. Facility and Equipment inspection: description of areas and equipment inspected (cutting equipment, flux ovens, electrode ovens, welding machines, etc.)

c. Welder qualifications received: note number of welders, welder operators, and tack welders for each process

d. Welders observed: IDs, type of welding

e. WPSs: IDs observed in use

f. Preheat: applied temperature, required range, weld joint(s)

g. Heat number tracking data received from QC

h. Weld pass observation: IDs, visual appearance

i. NDT performed by QC: operator, company, methods, weld joint(s) or report number(s)

j. Laydown and assemblies

k. Heat straightening or curving: notification, locations, method, or report number(s)

l. List piece marks inspected/released for shipping

Michigan Department
of Transportation
5617 (11/18)

FABRICATION INSPECTION REPORT

To be completed by the QA inspector and included in the final project documentation file.

REPORT # 1

GENERAL INFORMATION		
INSPECTION AGENCY MRED Inc.	INSPECTOR Roy Biv	DATE 17 April 2020
FABRICATOR / LOCATION Steel Bridges LLC		CONTROL SECTION 6817540-111032
JOB DESCRIPTION US 81 Bridge over Running River	SIZE AND ELEMENT TYPE 54" Weathering Steel Plate Girder	JOB NUMBER 191254C
STATUS OF FABRICATION FOR PERIOD ENDING Week Ending 17 April 2020	REQUESTED DELIVERY DATE 15 August 2020	FABRICATED 2%

COMMENTS

13 April 2020

CONDITIONS

Air Temperature - 45 degrees Fahrenheit
Relative Humidity – 38%
Partly Sunny
Work Exposure – Work is fully enclosed with limited exposure to elements

ACTIVITY

Traveled to Steel Bridges' facility in Anytown USA. Arrived at the facility at 9:30AM.

I met with Joe Welder, Plant Manager, and Frank Stine, Quality Control Manager at 10:00AM in Frank's office to discuss the current schedule at the plant. Currently, the shop has all material for the project in the yard and ready for production. The project consists of 25 welded plate girders, cross frames, and end diaphragms. The plant intends to start cutting diaphragm flange material on 14 April 2020 and begin flange splicing on 16 April 2020 with a completion date of 31 July 2020. The shop drawings have been submitted and approved by MDOT and were provided to me at the meeting. I requested the current MDOT welder qualification/continuity records and approved weld procedure specifications to be used on the project. Joe stated that he would supply that information later today. The meeting concluded at 12:00PM.

I received the certifications and WPSs from Joe Welder and reviewed the information. All certifications are up to date and the WPSs have been reviewed and approved by MDOT in accordance with MDOT SSC and the MDOT Structural Fabrication Unit Quality Manual with the except of WPS 19-SAW-1G-x. I emailed Bob Otremba with MDOT and copied Frank Stine regarding the unapproved WPS.

Joe Welder furnished their copy of MDOT Form 0501 (Material Source List) and Certified Mill test Reports for the material to be used on the project. I reviewed the list for verification tomorrow.

HOURS WORKED

Travel time - 2 hours 30 minutes
Total time at the plant - 5 hours 30 minutes (includes report and form preparation time)
Hours worked on report and form preparation - 0:30 hours
Total hours worked on MDOT project - 8 hours

14 April 2020

CONDITIONS

Weather Conditions:
Air Temperature - 48 degrees Fahrenheit
Relative Humidity - 35%
Mostly Cloudy
Work Exposure – Work is fully enclosed with limited exposure to elements

ACTIVITY

I arrived at the plant at 7:30AM. The material on MDOT Form 0501 was reviewed for conformance and verified for acceptance. The following material has been reviewed and the hold point for material inventory was verbally released to Frank Stine.

MDOT Material Spec.	Material Item	Supplier	AASHTO M270 Grade	Location	MSL	Visually Inspected*	Accepted
906.04B	1" Plate	Nucor Yamato	50W	Tuscaloosa	Yes	Yes – 100%	Yes
906.04B	3"x3" Angle	Gerdau	50W	St. Paul, MN	Yes	Yes – 100%	Yes
906.04B	½" Plate	SSAB	50W	Bettendorf, IA	Yes	Yes – 100%	Yes
906.04B	2" Plate	Arcelor Mittal	50W	Burns Harbor	Yes	Yes – 100%	Yes
906.04B	3/8" Plate	Arcelor Mittal	50W	Burns Harbor	Yes	Yes – 100%	Yes

* Note: % value represents percent of total project quantity on hand at the facility in the inspection scope.
I reviewed the CMTRs and verified the heat numbers of the received material in the yard and started filling out Form 0538D. The plant began cutting the angles for the diaphragms and cross frames. I visually inspected the material for dimensions and found the material in conformance with the shop drawings.

Plant equipment and facilities appear to be in working order – no notable equipment was observed out of order.

HOURS WORKED
Total time at the plant - 8 hours
Total time spent out in the plant - 6 hours
Hours worked on reports and calculations - 2 hours
Total hours worked on MDOT project – 8 hours

15 April 2020

CONDITIONS
Air Temperature - 47 degrees Fahrenheit
Relative Humidity 66%
Cloudy - Light precipitation
Work Exposure – Work is fully enclosed with limited exposure to elements

ACTIVITY
I arrived at the plant at 8:00AM. The fabricator had started cutting flange material for splicing. Frank provided me with a copy of the heat numbers and the proposed piece marks the plates will be incorporated into.
I received verification from Bob Otremba that the WPS 19-SAW-1G-x has been reviewed and approved by MDOT, but the fabricator was not using the stamped WPS on the shop floor; I notified the QC Manager who resolved the issue before any welding. The angles and gusset plates for 12 each of intermediate diaphragm piece marks D1 and D2 have been tack welded and final welding has commenced using FCAW. I observed welder Don Pardo (clock stamp DP1) preheat the joints to be welded and verify preheat with a Tempil Stik. As Don welded, the machine settings were verified to the approved welding procedure that was located with the welding machine. The visual appearance of both the tack welds and the production weld passes indicates the welds should pass final visual inspection.

HOURS WORKED
Total time at the plant – 9 hours
Total time spent out in the plant – 8 hours 30 minutes
Hours worked on reports – 30 minutes
Total hours worked on MDOT project – 9 hours

16 April 2020

CONDITIONS
Air Temperature – 46 degrees Fahrenheit
Relative Humidity – 38%
Cloudy
Work Exposure – Work is fully enclosed with limited exposure to elements

ACTIVITY

The plant has cut and prepared four flanges for butt splicing. The piece marks that the flanges are to be incorporated into are B1A, B1B, B2A, and B2B.
The SAW flux ovens were verified to the proper temperature and the type of flux was confirmed to meet the specifications of the approved WPS.
I verified the joint preparation and fit up and observed welder Sam Iam (clock stamp SI2) preheat one joint and commence welding the root passes for the joint. The root passes visually appeared to indicate proper welding technique is being utilized subject to NDT.
I met with Frank Stine in his office at 1:00 PM until 2:00 PM to discuss the schedule for NDT on the joints currently in production. WERT4U Inc. will be radiographing tonight. Frank provided copies of the certifications and eye exams for the personnel who will be performing the work. The certifications and eye exams were current.
I continued to verify root pass and intermediate pass welding for the remainder of the joints to be radiographed tonight. Visual appearance remains the same as noted,
I returned this evening to witness the RT set up and shots.

HOURS WORKED
Total time at the plant – 12 hours
Total time spent out in the plant – 11 hours
Hours worked on reports – 1 hour
Total hours worked on MDOT projects – 12 hours

17 April 2020

CONDITIONS
Air Temperature – 48 degrees Fahrenheit
Relative Humidity – 40%
Sunny
Work Exposure – Work is fully enclosed with limited exposure to elements

ACTIVITY
I arrived at the shop at 6:30 AM and reviewed the NDT reports. There were no rejected welds indicated in the report and as reviewed by QC. A copy of the RT reports was placed in the job file. The shop continues to cut flange and web material.

HOURS WORKED
Travel time – 2 hours 30 minutes
Hours worked on reports and reviewing NDT reports and film – 4 hours
Total time worked on MDOT project – 6 hours 30 minutes

Appendix A3: SQS for Prestressed Concrete Beams

Revision 0 – 24 January 2020

MDOT SUPPLIER QUALIFICATION PROGRAM

MDOT SUPPLIER QUALIFICATION STANDARD

FOR

PRESTRESSED CONCRETE BEAMS

MDOT SUPPLIER QUALIFICATION STANDARD

for

PRESTRESSED CONCRETE BEAMS

The Michigan Department of Transportation (MDOT) places a high value and importance on the dependability of suppliers providing main member bridge prestressed concrete beams.

MDOT believes that an effectively implemented, regularly maintained and regularly audited quality management system (QMS) is a key indicator of a Supplier's ability to produce a quality product. MDOT will accept products from suppliers who demonstrate a proactive QMS with procedures and processes that consistently deliver quality to the State. To assess that demonstration of quality MDOT conducts assessments of the readiness of the Supplier's QMS to meet contract requirements for prestressed concrete beam projects.

By implementing the requirements of this Standard consistently, MDOT projects can be produced and delivered with minimum error, deviations and rework. This improves quality for MDOT and should provide profitability for the Supplier.

Prime contractors may choose from this list with confidence that the minimum QMS has been demonstrated by the Supplier. The Supplier has also demonstrated an understanding of MDOT requirements for this product.

Compliance with this program meets the requirements of the required Contractor Quality Control Plan (QC Plan) referenced in the MDOT *Special Provision for Quality Control and Acceptance of Structural Precast Concrete* (12SP-708C) and this program. Note that portions of 12SP-708C are repeated, referenced and identified here for Supplier convenience.

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Program Rules

A. Definitions 79
B. Scope 82
C. Requirements for Participation 82
D. Documentation Audit 83
E. Onsite Audit 86
F. Required Demonstrations and Observations 87
G. Objective Evidence/Access 87
H. Audit Team 87
I. Audit Termination 88
J. Nonconformances (found during MDOT audits) 88
K. Successful Audit 88
L. Special Audit 89
M. Ongoing Assurance 89
N. Approved Supplier List 89

Standard

1.0 Documenting Program QMS Elements—Documented Procedures 93
2.0 Program Elements of the Supplier's QMS 94
3.0 References 94
4.0 Section number not used 95
5.0 Management 95
6.0 Specification Review 97
7.0 Design and Detailing 99
8.0 Quality Document Control 100
9.0 Quality Record Control 101
10.0 Purchasing 101
11.0 Identification and Traceability 102
12.0 Fabrication Process Control 104

13.0 Inspection 106

14.0 Control, Calibration and Maintenance of Inspection, Measuring and Test Equipment 109

15.0 Control of Nonconformance 111

16.0 Corrective Action 112

17.0 Handling and Storage 114

18.0 Training 114

19.0 Internal Audit 115

20.0 Annex 115

Program Rules

Commentary: Throughout this Standard, clarifications and examples have been provided to assist the Supplier in understanding the requirements. Commentary should be considered non-mandatory.

A. Definitions

Definitions are based on MDOT Special Provisions, MDOT Construction Specifications and industry codes and standards referenced by those MDOT documents. In case of a conflict in the contract documents, see Division 1 of the MDOT Standard Specifications for Construction for order of contract document precedence. Definitions offered here are specific to this Supplier qualification program and may not align precisely with some PCI publications or related industry documents.

Note: use of the term Contractor in this section and in MDOT 12SP-708C is synonymous with the term Supplier. Contractor in the 12SP-708C refers to the Prime Contractor and its Suppliers. The Prime Contractor is responsible to meet these requirements and all project contract requirements. However, it is understood that it is the Prime Contractor's Suppliers who are responsible for compliance to the QC requirements.

Air Content of Fresh PCC	The recorded air content of fresh PCC sampled and tested according to MDOT's Special Provision for Quality Control and Acceptance of Structural Precast Concrete (12SP-708C).
Alkali-Silica Reactivity (ASR)	A chemical reaction which occurs over time within PCC between highly alkaline cement paste and reactive forms of silica found in some aggregates. In the presence of moisture, an expansive ASR gel is formed which can exert pressure within the PCC, causing random cracking and premature deterioration of the PCC.
CAR	Corrective action request or corrective action response.
Concern	Concerns may be related to accuracy, consistency, individual actions or other issues that could impact product quality, but do not yet constitute a nonconformance.
Correction	The measure(s) taken to bring a single nonconforming product or process into conformance with specified requirements. It may be a reaction to a process parameter that is approaching an established QC Action Limit. It may also be an action to fix a single nonconformance.
Corrective Action	The action or actions undertaken to identify and eliminate the root cause of a product nonconformance or process nonconformance to prevent its recurrence. Corrective action is not the repair or rework of identified nonconforming product or process to meet specified requirements (correction). Note – the term "corrective action" may also be used in the MDOT special provisions, and in this case means "correction" as defined in this document.
Critical Nonconformance	Finding that directly affects and severely reduces the quality and acceptability of the product, possibly leading to premature failure, excessive maintenance, or diminished service life. Examples of critical nonconformance may include but are not limited to the following items, at a minimum, that are stipulated in the project specifications: Use of nonconforming material (defective, unauthorized, etc.), unauthorized modifications or substitutions, practices violating code or specification requirements, falsification of any record, absence of required documentation for critical items and unqualified individuals performing critical tasks.

Finishing	Finishing is a stage in the manufacture of each element that begins after an element has been cured and does not begin until 28-day compressive strength has been achieved. Finishing activities may include grouting of small holes, end finishing and grouting of small tight cracks. Finishing is expected and required for each concrete element.
Floating	Working the top surface of freshly placed PCC to create a specified smooth surface.
Implementation (of a quality procedure)	A quality procedure is implemented when the process is documented and maintained; responsible personnel are aware of their responsibilities in the procedure and the records generated by the procedure are executed. It is maintained when it is audited regularly and updated to meet changing requirements
Inspection and Test Plan (ITP)	That part of a quality control plan that defines detailed quality control activities performed by production, QC, and QA inspection, oversight, approvals, or hold points at specific steps. It is typically a separate document referenced by the quality control plan.
Job Mix Formula (JMF)	The actual batch quantities (mixture proportions) of each constituent included in the PCC mixture, based on adjustments to the target weights attained from the mix design process necessary to optimize the PCC mixture properties.
Major Nonconformance	Finding related to the QMS, which directly or indirectly affect production dependability and consistency, potentially leading to reductions in product performance, quality and reliability. Examples of major nonconformance may include but are not limited to the following items, at a minimum, that are stipulated in the project specifications: unqualified employee, missing procedures, poor equipment condition leading to material or manufacturing nonconformance, material quality, drawing accuracy, vendor services and inadequate supervision.
Minor Nonconformance	Finding related to documentation shortcomings or other minor infractions within the system application that are not expected to cause multiple nonconformities or significant product deficiencies in current or future projects. Examples of minor nonconformance may include but are not limited to the following items, at a minimum, that are stipulated in the project specifications: Expired or incorrect calibration, inadequate training, specification not current, missing procedure steps and illegible identification.
MDOT Program Manager	A managing engineer of the MDOT Bureau of Bridges and Structures – Structures Construction Section or designee with the decision-making authority for the program use and Supplier participants. The Program Manager functions on behalf of the Engineer in decisions about Supplier's capability to supply projects.
PCC Mix Design	The process, by which the PCC mixture performance characteristics are defined, based on selected materials, performance requirements, environmental exposure considerations, placement methods and other factors that control the plastic and hardened properties of the PCC in efforts to produce an economical and durable product. Proportions yielding the desired characteristic are established by testing.
Program	The MDOT Supplier QMS Assessment Program
Production Lot	A discrete cubic yard quantity of PCC containing the same JMF and used for the same application as described in 12SP-708C.
QAI	Quality Assurance Inspector. Term used in this Standard to refer to the Inspector representing the Engineer. The QAI is typically on site daily or at some lesser frequency to observe and perform sample inspections and tests to demonstrate conformity to project requirements on behalf of the Engineer.

QCI	Quality Control Inspector. Term used in this Standard to refer to the Supplier's inspector(s). The QCI is performing and documenting measurements and tests required to demonstrate conformity to project requirements on behalf of the Supplier.
Quality Assurance (QA)	Activities administered by MDOT's quality assurance inspector (QAI) dealing with acceptance of the product, including, but not limited to, materials selection, sampling, testing, fabrication inspection and review of Contractor QC documentation. All PCC QA sampling and testing will be administered by the Engineer.
Quality Control (QC)	All activities administered by the Contractor's quality control inspector (QCI) to monitor, assess and adjust production and fabrication processes to ensure the final product will meet the specified levels of quality. Including, but not limited to: training, materials selection, sampling, testing, project oversight and documentation.
QC Action Limits	A range of values established by the Contractor in the QC plan that if exceeded, requires that correction be taken by the Contractor to restore the continuity and uniformity of the mixture and methods in conformance with specification requirements. The QC action limits must not exceed the QC suspension limits; however, the Supplier must consider risking product acceptance and is expected to address such out of control processes with its nonconformance control and possibly corrective action procedures.
QC Plan	The plan developed by the Contractor describing, in detail, all aspects of production and fabrication for the project to ensure consistent control of quality to meet specification requirements. Note: The Supplier's Quality Systems documentation could satisfy the requirement if it addresses the specifics of MDOT project requirements. If it does not, there must be a supplemental document or documents which identify modifications to the Quality Systems Manual or its referenced procedures. Typically, the QC Plan is a combination of the Quality Systems Manual with referenced procedures, and a document summarizing specific modifications to the manual and procedures needed to meet MDOT-specific requirements (such as 12SP-708C and this SQS Program Standard), and an ITP summarizing the inspections and tests to be performed in executing quality control.
QC Manager	An employee of, or consultant engaged by the Contractor when arrangements have been previously approved by MDOT, responsible for developing and overseeing all aspects of QC for the project. This includes, but is not limited to preparing the QC plan, managing all QC personnel, communicating routinely with the production personnel to ensure quality, initiating corrective action and suspending operations when the process is found to be producing non-conforming materials and preparing and submitting all necessary QC documentation to the Engineer within the specified time period.
QC Suspension Limits	A range of values that if exceeded on a single QC test, requires that the Contractor suspend operations and determine, correct and document the deficiencies before resuming production. The QC suspension limit must not exceed specification limits.
RFI	Request for Information RFIs referred to in this document are formal written communications initiated by the Supplier to the Owner or through the Contractor to the Owner. The requests ask for clarification, missing information, or approval of an alternate solution to fabrication from the design drawings or approved fabrication and erection drawings.
Repairs	Repairs are conducted to bring an element to project conformance for nonconformances such as cracks larger than acceptable by project or code requirements. Repairs may not be required for each element.
Sample	A representative quantity of PCC taken during production which is used to measure the quality characteristics for the PCC.
Sampling Rate	The number of times the fresh PCC is sampled.

Specification Limits	The threshold values placed on a quality characteristic used to evaluate the quality of the material.
Strength Sample Test Result	The average of three companion 28-day compressive strength test specimens for prestressed structural precast concrete taken from the same sample of PCC is considered a strength sample test result.
Strength Test Specimen	A strength test specimen is an individual 6-inch by 12-inch strength test cylinder or 4-inch by 8-inch strength test cylinder molded and cured according to AASHTO T 23/ASTM C 31 and tested according to AASHTO T 22/ASTM C 39. All QC strength test specimens must be the same nominal size. Strength test specimen cylinder size of 4-inch by 8-inch is permitted only if the nominal maximum coarse aggregate particle size, as specified for the coarse aggregate in the PCC mixture, is 1-inch or less.
Sublot	A portion of a production lot represented by a complete set of QC tests of this special provision. The Engineer and Contractor may agree to reduce the typical sublot size based on other project conditions.
Supplier	Capitalized in this Standard, the term refers to the prestressed precast concrete beam fabricator/manufacturer who is seeking the opportunity to provide products and services to MDOT for a specific project. Contractors awarded MDOT projects select only qualified Suppliers for the work.

B. Scope

This requirement applies to Suppliers (as defined above) providing main member bridge prestressed concrete beams. MDOT may apply this assessment requirement to other supply types using project specific special provisions.

C. Requirements for Participation

The Supplier must successfully complete a MDOT QMS assessment prior to the start of manufacture to ensure compliance to contract specifications, as well as compliance with the requirements of the Precast/Prestressed Concrete Institute (PCI) certification program, as required by the contract.

Suppliers must request approval to provide a specific product category. Requests are made in writing to MDOT on the Supplier application form. The Supplier may apply for any of the PCI program categories that the firm has the capability and expertise to provide. Before applying for participation to this program, potential suppliers must be current certified plants by PCI for their declared category. See required program categories described under the Approved Supplier List (ASL) in Section N of this document.

Any costs incurred by the Supplier to participate in the QMS assessment will not be paid for by MDOT. These costs include the Supplier's time, labor and materials to provide the requested documentation and participation in the onsite audit and the resolution of identified nonconformances.

There are two steps to the assessment process, the Documentation Audit and the Onsite Audit

Documentation Audit

A full documentation review of the Supplier's QMS will be conducted remotely by MDOT. The Supplier must resolve critical and major nonconformances from this review prior to scheduling the onsite audit. All document review nonconformances must be resolved prior to granting Supplier approval. Requirements for this audit are detailed later in this document.

Onsite Audit

The fabrication functions typical of the category(s) must be underway for the onsite audit. If the applicant Supplier has no work in house, appropriate exercises or mock work will be determined for demonstration. Notification of a "no work situation" must be received at least 14 days before the scheduled onsite audit to allow for adequate preparation and planning for both the auditor and the Supplier.

An onsite audit can be scheduled within 21 days if project status is critical. All nonconformances identified during the onsite audit must be addressed satisfactorily to consider the onsite audit successful.

The Supplier must resolve critical and major nonconformances from this audit before qualification is achieved and the Supplier is listed on the ASL.

Success is determined after resolution of nonconformances discovered during the assessment process. A full description of nonconformances and the required resolution by corrective action process is included later in this document.

Complete details of the onsite audit are included later in this document.

D. Documentation Audit

Documentation Submission Requirements

Suppliers submit QMS documentation for review and assessment, as soon as possible, to allow for a successful assessment. It is in the Supplier's best interest to submit the requested documentation in a timely fashion, as nonconformances must be resolved before the onsite audit is scheduled.

Submit the QMS documentation in a searchable PDF file, in the smallest size possible. If possible, submit the entire documentation in one PDF file. **Hard (paper) copies are not accepted**.

Include one sample of the following records completed with sample or actual data. As with all evidence gathered during the onsite audit, records submitted for documentation audit are considered confidential. It is highly recommended to redact business sensitive data such as prices, hours, and estimated number of personnel from actual project records prior to submittal. Quality documents (the Quality System Manual and related procedures and forms) should be submitted complete and without redaction, but special accommodations will be considered upon request.

Documents required for review prior to the onsite audit

Submit for the documentation audit:	
	Procedures or other documents covering the program elements
	Sample completed records that support program elements 1 thru 19 of the Standard:

	Sample shop drawing of a representative member that is typical of the prestressed beams to be supplied to MDOT
	Verification of the qualification of mix components Mix design documentation sample including: ▪ Independent certification of source materials and/or general certification by plant as specified in the MDOT Material Source Guide ▪ Identification of the designer and method to submit to Owner ▪ Mix sequence and method ▪ Required tests similar to production tests listed for QC Records Production
	One sample set of QC record(s) for strand data: ▪ Strand material specification (outside source) ▪ Strand diameter (a value) ▪ Strand spacing (per design) (a value or sketch) ▪ Strand pre-tensioning (a value) ▪ Strand final tensioning (per design) (a value) ▪ Strand release sequence (a value or sketch)
	One sample set of QC record(s) for production: ▪ Verification of form construction tolerances (first unit or after form adjustment) ▪ Verification of placement of structural components, reinforcement, accessories and block outs in a form ▪ JMF verification ▪ Air test ▪ Slump test ▪ Unit weight ▪ Temperature (ambient air, concrete) ▪ Creation and ID of strength (transfer and final) test cylinder(s) ▪ Tensioning strand elongation
	One sample job specific quality plan or ITP (completed)
	One sample set of QC records for release of strands: ▪ Symmetric release per order specified ▪ Transfer strength test cylinder result
	Nonconformance report or log
	Purchase Order (PO) form or other purchasing document that defines purchasing requirements for mix components, components placed in forms, weld consumables and buy America requirements for rebar and other steel embeds.
	Correction Action activity form, record or log (completed)
	Post-placement inspection record sheet: ▪ Dimensional accuracy including placement of inserts ▪ Openings are clear and correctly located

	One sample Post Pour Inspection Record which includes as a minimum: ▪ Surface finish and absence of defects ▪ Final acceptance and certification of product ▪ Verification of camber per design
	Procedure Qualification Test Records, one (1) for each process in accordance with AWS D1.4 (if work requires)
	Certifications for all personnel holding these credentials who will work on MDOT projects: ▪ For concrete testing: Michigan Concrete Association (MCA) Level I Concrete Field Testing Technician or *American Concrete Institute (ACI) Concrete Field Testing Technician Grade 1 *Note that the period of effectiveness for the ACI certification is reduced from 5 years to 3 years to be valid for MDOT recognition. ▪ For concrete strength testing: ACI Concrete Strength Testing Technician ▪ For JMF adjustment: PCI PQP Level III Plant Quality Control Technician, or MCA Level II Advanced Concrete Technician ▪ For laboratory aggregate sampling and testing: Michigan Certified Aggregate Testing (MCAT) Level I technician ▪ Other certifications required for general quality control – see Section 5.7 below.
	Welding Procedure Specification, one (1) for each process in accordance with AWS D1.1 Structural Welding Code—Steel, AWS D1.4 and AWS D1.6 (if work requires)
	Welder Qualification Test Record, one (1) for each process in accordance with AWS D1.1 Structural Welding Code—Steel, AWS D1.4 and AWS D1.6 (if work requires)
	Calibration (inspection and test equipment) log or record sample (showing accuracy, frequency and measured deviation): ▪ Holding tanks or metering devices (measuring admixtures to the batch) ▪ Scales ▪ Water measuring devices ▪ Tensioning equipment, dynamometers, hydraulic gages and load cells ▪ Force in hydraulic jacks ▪ Strength specimen testing gages ▪ NDT
	Project Specification Review Record
	Internal Audit Record
	Management Review Record or minutes from one or more meetings addressing the items in QMS Review
	Job Descriptions and Evidence of Qualification Include job descriptions and documented evidence of qualification for key personnel as identified in the Supplier organizational chart, including QCIs. Documented evidence of qualification includes certification records, training history with supporting records, and a written record of work experience, preferably verifiable, which supports the responsibilities and authorities detailed in the job description. Documented experience of your registered engineer in the design of precast concrete (on staff or subcontract).
	Facility Plan/Plant Layout and Equipment List

Organizational chart of key personnel showing reporting relationships and highlighting QC reporting and access

E. Onsite Audit

The onsite audit will confirm objective evidence of compliance through observation, review of quality documents and interviews with responsible personnel. a simple review may be all that is needed. However, copies of documents and photos of work may be collected as objective evidence and made part of the confidential report. It is understood that the Supplier may wish to redact business sensitive data such as prices, hours, agreements and other proprietary items before making electronic or digital copies.

Proprietary procedures and information cannot be withheld from the audit process if they are needed to demonstrate compliance

The onsite audit will be scheduled after successful completion of the documentation audit.

The audit team will work to avoid disruption to ongoing production as much as possible. However key personnel participation will be necessary to complete the work.

If the audit team schedule is impaired or it is prevented from completing the audit, the elements not sampled will be considered nonconforming.

Commentary: The intent of the requirement is to motivate the Supplier to schedule work and communicate with MDOT auditors such that all elements are sampled. Unacceptable impairment includes but is not limited to: a) vacationing key personnel, b) plant shut-downs without notice, c) lack of materials, d) failed provisions for foul weather concreting. e) access to ongoing projects and project information potentially for other agencies. f) access to documents or processes identified as proprietary by the Supplier. On a case-by-case basis, MDOT auditors will recommend to the MDOT Program Manager halting the audit and rescheduling in lieu of issuing nonconformances.

Please arrange access for the audit team to these functional positions for the onsite portion of the audit. Certifications and qualifications will be verified during the onsite audit. Assure that these personnel are represented in the organizational chart.

- Registered Professional Engineer - (on staff or preferred independent professional)
- Strength Testing Technician(s)
- QCI
- QC Lab Technician(s) performing required testing for concrete and concrete components
- QC Management – Lab manager, Lab Technician, Inspection Manager
- Detailing Staff
- Detailing Management
- Mix Design/Adjustment Technician
- Management team members or Quality Committee – Managers responsible for the review and effective implementation of the QMS. Include those who manage these processes at a minimum: specification review, design and detailing, document control, purchasing, ID and traceability, fabrication process control, Inspection, and the quality management system processes of nonconformance, corrective action, internal audits and training

Commentary: Regarding the requirement for Suppliers to have access to a Registered Professional Engineer, refer to PCI MNL-116, 1.3.2 Engineering, specifically for responsibilities of a plant engineer other than structural design.

F. Required Demonstrations and Observations

	Moisture control practices for when aggregate is wet from weather conditions
	Mixing and Batching – measurement and recording; moisture and temperature control
	Production Testing: ▪ Air ▪ Slump ▪ Temperature ▪ Density
	Placement of structural components, reinforcement, accessories and block outs in a form
	Tensioning operations: ▪ Anchor/cone inspection ▪ Jacking/tensioning procedure and sequence ▪ Measuring strand elongation prior to pour ▪ Transfer/de-tensioning including sequence
	Cylinder break test (any stage and associated record keeping)
	Placement of concrete in the form and floating (if work requires)
	Removal from the form
	Curing including measuring final camber
	Finishing (repair and patching)

These items can be verified onsite by record and interview, however demonstration with production product is preferred.

G. Objective Evidence/Access

The Supplier agrees to allow access to all projects active at the time of an audit that employ processes similar to those that will be used on MDOT work. Auditors will assess the Supplier's control of quality and implementation of the Supplier's own procedures for conformance with project specifications to demonstrate an effective system. Unique requirements of the MDOT specifications or project special provisions will not be assessed on non-MDOT projects. However, Suppliers must have procedures in place and have knowledgeable personnel and equipment to demonstrate capability for any unique MDOT requirements.

H. Audit Team

The team may be a single auditor or multiple personnel to assess a Supplier depending on:

- Size of the facility
- Number of employees
- Observation of the Audit process by auditors or MDOT personnel
- Complexity of the Supplier's QMS
- Complexity of the audit scope or assignment from MDOT.

I. Audit Termination

This is not anticipated; however, the Auditor may terminate the audit immediately for the following reasons:

- Safety
- Refusal of access to product or documentation including non MDOT work needed to demonstrate capability

J. Nonconformances (found during MDOT audits)

Nonconformances discussed here refer to written observations backed by objective evidence and issued officially by MDOT. A definition of each type of nonconformance can be found in the Definitions section of this document. Suppliers' definitions may differ; however, the following will apply to nonconformances issued by MDOT regardless. Suppliers' resolve these nonconformances using their internal corrective action process. Send responses to MDOT using the forms provided by MDOT.

See Figure 1 in the mandatory document annex for more detailed requirements

Critical Nonconformance

The Supplier must respond to critical nonconformances within 7 calendar days from receiving formal notification of the findings by MDOT.

Major Nonconformance.

The Supplier must respond to major nonconformances within 14 calendar days from receiving formal notification of the findings by MDOT.

Minor Nonconformance.

The Supplier must respond to minor nonconformances within 21 calendar days from receiving formal notification of the findings by MDOT.

Commentary: Nonconformance is communicated in written audit reports. Seven days is the response time for a critical nonconformance. A critical item suggests that the nonconformance is serious enough that it will impact quality more immediately and jeopardize a product. Seven days is a long time in these cases. Production may be stopped more urgently if the issue is left unchecked and if continuing without correction would produce product that does not meet contract requirements. Extensions for resolution time will be granted on a case-by-case basis.

K. Successful Audit

The results of the onsite audit are reviewed by the MDOT Program Manager.

A successful audit is achieved when all elements of the Supplier's QMS documentation are found compliant or commendable and systems are effective at controlling the quality of product. If any nonconformances are found during the documentation audit, the audit team will attempt to resolve and close them with the Supplier during the documentation audit and before the onsite audit. Some items or issues may be left for verification during the onsite visit.

If any nonconformances are found during the onsite audit, the audit can still be successful if each is addressed and closed before fabrication begins. If critical or major nonconformances are not resolved before the start of fabrication, additional inspections or audits may be imposed by the MDOT Program Manager until they are closed.

Commentary: Expected audit cycle for maintaining approval status is annual. MDOT may however schedule recurring audits more frequently depending on past audit performance.

L. Special Audit

Suppliers may be subject to short notice special audits throughout fabrication until project acceptance. In the event a critical nonconformance, or two or more major nonconformances are observed by MDOT during execution of the contract, MDOT reserves the right to perform a short notice, no less than 24 hours, onsite special audit of the Supplier's QMS and handling of issues. Special audits may be scheduled to resolve critical and major nonconformances that are not adequately addressed by the Supplier.

A special audit may also be requested outside of a project scope when there is concern about the control of a process to maintain Supplier qualification.

M. Ongoing Assurance

The MDOT Program Manager may plan visits by an auditor at any time during project fabrication. The visits may be general surveillance in nature or may have specific target objectives to sample compliance.

N. Approved Supplier List

It is the Contractor's responsibility to use only qualified Suppliers on MDOT projects. Qualified Suppliers have satisfied the requirements of this program and are listed on the Approved Supplier List (ASL) according to their declared product category and approval status. The ASL can be found in MDOT's Structural Fabrication Quality Manual (SFQM). The SFQM will have a link to the ASL located on our webpage.

If a Contractor chooses to select a Supplier who is not on the ASL for products or services to be supplied, the products or services will not be accepted on the project.

Special arrangements may be granted in advance by the Engineer to expedite qualifying an unlisted Supplier before fabrication or the service begins. It is the Contractor's responsibility to obtain this consideration in advance and in writing from the Engineer.

Program Categories

The scope of MDOT document reviews and MDOT audits will include criteria specific to the Supplier's declared category. Contractors may only consider a Supplier for a MDOT project if they are listed for the specified products and services. For prestressed concrete beams, MDOT uses the PCI categories for prequalification certified by PCI for:

- Category B3, Prestressed Straight Strand Bridge Beams, or
- Category B4, Prestressed Deflected Strand Bridge Beams.

ASL Status and Restrictions

The approval status of the Supplier will assist contractors in making selections for their upcoming projects. Details on initial status, maintaining approved status, restrictions, and terms of probation, disqualification, and dismissal are provided in later sub-sections. Depending on initial and continuing audit results, a Supplier's status may be indicated on the Approved Supplier List as:

"Approved" (Full Status): The Supplier can be selected for any work in the categories for which they are listed.

"Approved – Provisional" (Restricted Status): The Supplier can be selected for any work in the categories for which they are listed, but MDOT may restrict the number of project types and/or product quantities allowed to be produced at one time.

"Approved – Probation" (Restricted Status): The Supplier can be selected for any work in the categories for which they are listed, but MDOT may require additional third-party involvement. The level required will be indicated on the ASL as "Level I" or "Level II".

"Disqualified": Full requalification is required for re-entry into the program.

"Dismissed": A period of suspension from the program is required before full requalification and re-entry into the program.

"Hiatus": The Supplier voluntarily removes itself from the Program. The same restrictions as Unlisted apply. They are on the ASL but are not available for selection by a contractor for a project.

Unlisted: The Supplier cannot be selected for MDOT work from bid time to project completion. They are not visible on the ASL.

Initial Status and Unlisted Suppliers

Before placement on the ASL, both the Supplier's QMS documentation and its QMS execution are successfully assessed for compliance to this program.

The Supplier remains unlisted until all document review and onsite audit nonconformances are addressed satisfactorily, assuming there are no critical or major nonconformances.

Contractors may request expedited qualification of unlisted Suppliers prior to project commencement, based on MDOT resource availability and enough notice. After successful assessment per the requirements of this program, MDOT would issue qualification documentation as evidence of approval until such time that the ASL is updated.

Maintaining Approved Status

Unrestricted approved status on the ASL for the categories audited continues by maintaining a functioning QMS, passing recurring MDOT audits without major or critical nonconformances and by producing work without serious product nonconformance. Minor audit nonconformances, if any, are resolved within the required timelines.

Commentary: Serious product nonconformance is determined by MDOT on a case-by-case basis. At a minimum, impacts to critical path and public safety or structural integrity concerns are "serious" by nature.

Provisional Approval

Major audit nonconformance or repeat minor product nonconformance may result in a provisional approval status.

As stated above, the Supplier may be restricted to a single project type, product category or limited product quantity for either a given project or for a given time period.

Probation

Supplier failure to address nonconformances in the time frames described in the Nonconformance Severity Chart or a significant number of major or critical nonconformances or serious repeat product nonconformance may result in probation and imposed third-party requirements.

At its discretion, MDOT may require Supplier QC Oversight (Level I Probation) or Third-Party QC (Level II Probation). Probation level will be indicated on the ASL and communicated to the Supplier in writing. Additional audits may be required to check compliance to the terms of probation.

- **Level I Probation– Supplier QC Oversight:** Supplier must retain and pay for an independent inspection and testing firm acceptable to MDOT to verify compliance to its QSM through oversight. The oversight firm must review all QC reports, material certifications, and be on-site to witness Supplier QC perform all functions stated in their QMS regardless of required frequency.
- **Level II Probation – Third-party QC:** Supplier must retain and pay for an independent inspection and testing firm acceptable to MDOT to execute the Supplier's quality control program. The Supplier continues to execute their QC program and is responsible for the quality of the product.

Third-party QC will be responsible for developing project-compliant inspection and test plans as well as performing all required Supplier QC activities including producing required QC reports and documentation. Third Party QC will review the work and documentation produced by the Supplier QC operation. They also periodically observe the work of Supplier QC for improved technique and improvement. Significant discrepancies are resolved and may be reported to MDOT.

Commentary: Suppliers achieving Approved-Full Status are not required to use third-party quality control.

MDOT reserves the right to impose additional controls by the Supplier if MDOT is not satisfied the Supplier's QC is capable of functioning without assistance. Note: MDOT QA activities are required as in the past.

Disqualification

Continued failure to comply with program requirements or continued non-response by the Supplier may result in disqualification from the program.

Re-entry into the program requires full requalification per the Reinstatement section below.

Dismissal

Gross disregard for program adherence or long-term unresponsiveness or serious product failures may result in the Supplier being dismissed from the program. Dismissal requires both full requalification and a specified period of suspension from the program. Reapplication will require evidence of process improvement during the period of absence.

Reinstatement

From provisional approval: MDOT will determine requirements for removing provisional restrictions on a case-by-case basis. Decisions will be based on project performance and may include additional audits to check implementation or product mock-ups or other activities that demonstrate improved capability.

From probation: At its discretion and based on Supplier performance, MDOT will specify the duration of the probation period. Product mock-ups or other activities may be requested by the MDOT Program Manager to demonstrate improved capabilities prior to removing probationary status.

After disqualification: If disqualified from the program, the Supplier may contact the MDOT Program Manager in writing to reapply for listing on the ASL. In order to resume active ASL status, any outstanding CARs from previous audits prior to removal must be fully resolved before the reapplication process can begin. A new set of QMS documentation must be assessed and an onsite audit is required to be reinstated.

After dismissal: During the specified period of suspension, the Supplier must take serious steps to improve its quality management system. After serving the suspension, the Supplier must request reinstatement into the program in writing. The request must include documented evidence of process improvement and a commitment to MDOT program requirements. Reinstatement will require complete requalification including documentation review and onsite audit.

As determined by the MDOT Program Manager, circumstances may warrant further demonstrated performance before reinstatement from any status.

Hiatus

Contact the MDOT Program Manager in writing to voluntarily be removed from the Program and discontinue the periodic assessments required to maintain status. In order to resume active ASL status, any outstanding CARs from previous audits prior to removal must be fully resolved before the reapplication process can begin. Complete requalification including resubmittal of QMS documentation and an onsite audit is required to be listed again.

If the Supplier left the program under disciplinary status (disqualification or dismissal), that status continues during this reapplication process. A Supplier should plan 6-9 months for reinstatement working through this status.

PROGRAM STANDARD
Required QMS Documentation

The required program elements of the QMS are listed below. These elements must be addressed in the Supplier's QMS documentation and implemented in production practice. The documentation and onsite audits will confirm these elements have been addressed by the Contractor.

The documentation organization or style does not need to reflect the titles or order of these elements. A cross reference matrix against these elements is necessary to assist MDOT in evaluating documentation and to assist the Supplier in self evaluating the contents of their documentation and their practices.

The Supplier's QMS documentation must include procedures. The elements listed below may be addressed in a single quality manual or in a combination of documents.

To satisfy the MDOT requirement for a Contractor's quality control plan cited in the project special provisions, the Supplier may use separate documented procedures, a separate ITP, a quality manual, or a combination of all these. Quality control activities including observation, inspection and testing must be identified and related QC Action and QC Suspension Limits must be clearly defined for each activity. All these requirements are further explained in the special provisions and this standard.

Note: MDOT does not require the complete QMS documentation to be contained in single quality manual or document. However, it is suggested that at least a high-level quality manual be created to address the elements on a policy level as required by PCI certification. This high-level document should be crafted to address PCI certification requirements specifically for the requirement for PCI to execute direct approval. MDOT specific procedures may be referenced from that manual or reside separately at the Supplier's discretion and do not need to be directly approved by PCI.

1.0 Documenting Program QMS Elements—Documented Procedures

Documented procedures addressing each element of this program are required. It is not required that there is a separate procedure that addresses each element. The Supplier may combine element subjects and requirements in a way that best suits company culture and the firm's organization and processes.

Provide a cross reference matrix that shows where the system addresses the required program QMS elements. The matrix is best accomplished using a table format listing each procedure or QSM section number and a column for indicating the MDOT program element number addressed. This is an excellent basis to conduct an internal audit of compliance with MDOT program requirements.

Procedures must contain:

1) The purpose of the procedure, what will be accomplished or realized when this procedure is implemented.
2) Process definition that includes steps required for completion
3) Assignment of responsibility for performance
4) Assignment of responsibility for review, revision, and/or approval of the procedure
5) Identification of records that are generated
6) The frequency and accuracy required for the steps, especially for procedures describing inspection activities

Supplier's QMS

2.0 Program Elements of the Supplier's QMS

PROGRAM ELEMENTS		
3		References (current required for the project)
5		Management Responsibility
6		Specification Review
7		Design and Detailing
8		Document Control
9		Quality Record Control
10		Purchasing
11		Material ID and Traceability/Materials
12		Manufacturing Process Control
12.1		Form Loading and Strand Tensioning
12.2		Concrete Production and Placement
12.3		De-Tensioning/Transfer and Stripping
12.4		Final Curing and Finishing
12.5		Fabrication (steel)
12.6		Equipment Maintenance
13		Inspection
14		Control, Calibration and Verification of Inspection, Measuring and Test Equipment
15		Control of Nonconformance
16		Corrective Action
17		Handling and Storage
18		Training
19		Internal Audit

3.0 References

The scope of this program includes the applicable clauses and requirements of the current version (or contract version) of these documents:

- MDOT Standard Specifications for Construction
- MDOT Special Provisions and Supplemental Specifications
- PCI-MNL-116 Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
- PCI QSM-1—Preparation Guidelines for a Quality System Manual of a PCI-Certified Plant
- AWS D1.1 Structural Welding Code—Steel
- AWS D1.4 Structural Welding Code—Reinforcing Steel
- CRSI Code of Standard Practice
- Additional codes and standards called by the documents in this list

4.0 Section number not used

5.0 Management

5.1 Quality Policy Statement

The Supplier must craft a concise statement that is understandable and known by all key personnel. The statement must include how the company views their responsibility for quality and meeting customer project requirements. Define what national and regional quality standards the system is compliant with.

5.2 Quality Goal

Select at least one quality goal, where the objective is to improve quality efficiency in the delivery of product. This can be part of the quality policy or private to the management team.

Describe how the quality policy is communicated to key personnel.

5.3 Quality System Awareness

Describe how the Supplier assures that personnel are aware of the QMS and their responsibilities to achieve objectives. Choose meetings, internal audits, written communication or other effective method. Show objective evidence to record how awareness was accomplished.

5.4 Organizational Chart

Provide an organizational chart, graphic, narrative or other means to identify the key personnel showing reporting relationships. Assure that the top manager responsible for the facility is identified. Assure that the managers of the purchasing, design and detailing, manufacturing and quality process are identified, highlighting QCI and their reporting. These responsibilities may also be addressed by a QMS Committee responsible for the implementation of the QMS. Identify the Management Team on the organizational chart or other convenient method.

5.5 Job Descriptions and Documented Evidence of Qualification

Include job descriptions and documented evidence of qualification for key personnel as identified in the Supplier Organizational Chart, including QCIs.

Include responsibilities, authorities/decision making level and requirements for qualification in the job description for each key position or function. Personnel may be assigned more than one job function.

Documented evidence of qualification includes certification records, training history with supporting records, and a written record of work experience, preferably verifiable, which supports the responsibilities and authorities detailed in the job description.

5.6 Personnel Requirements

Specific titles and responsibilities are the duty of the Supplier. Titles used here are suggested and used for reference in this Standard, however these responsibilities are required and must be addressed in the Supplier's QMS.

5.6.1 Management Representative for Quality

Management must designate a position that is responsible for the maintenance and implementation of the QMS and the QC Plan that is part of the QMS. This position is a member of management but may perform other functions for the Supplier that do not conflict with these

responsibilities. Alternately, this responsibility can be handled by a Quality Committee with a designated member of management with the same responsibilities.

This position has the ability, responsibility and authority to:

- Ensure that documented procedures needed for the quality management systems are established, implemented and maintained in accordance with this Standard
- Report to executive management, the management team or the Quality Committee on the performance of the quality management system and any need for improvement. This can be organized during the required management review
- Assure there is a system of awareness to ensure that all employees are aware of the quality policy and become a part of the QMS at their level of responsibility
- Assure that managers and employees are committed to the system and that awareness of customer requirements is communicated at their level of responsibility
- Communicate with customers on matters relating to the quality management system

5.6.2 QC Manager

The QC Manager may delegate tasks and select responsibilities to personnel under their supervision. they must have full authority and responsibility to take all actions necessary for the successful implementation of the QMS and its QC plan including but not limited to:

- Monitoring and utilizing QC tests, control charts and other QC practices to ensure that delivered materials and proportioning meets specification requirements.
- Monitoring all materials prior to their use, to ensure their continued compatibility toward producing consistent quality.
- Periodically inspecting all equipment utilized in transporting, proportioning, mixing, placing, consolidating, finishing and curing to ensure proper operation.
- Monitoring materials stockpile management, PCC batching, mixing, transporting, placement, consolidation, finishing and curing to ensure conformance with specification requirements.
- Maintaining and submitting all QC records and reports to the Engineer or the QAI.
- Directing the necessary corrective action to ensure continual conformance within specification limits.
- Conducting or monitoring adjustments to the JMF.
- Observing PCC placement during the entire casting operation.

5.6.3 Personnel Qualification

The actual titles for personnel who perform these duties are the decision of the Supplier. Minimum requirements for qualification are listed here for these functions:

Function	Minimum qualification, certification or skill level
QCI	PCI Level II Plant Quality Control Technician
Concrete testing	Fresh Concrete Testing: ▪ MCA Level I Concrete Field Testing Technician, or ▪ ACI Concrete Field-Testing Technician Grade 1 Concrete Strength Testing: ▪ ACI Concrete Strength Testing Technician
Mix Design and Adjusting the JMF	▪ PCI Level III Plant Quality Control Technician, or ▪ MCA Level II Advanced Concrete Technician
Detailing personnel	Able to demonstrate competency to prepare shop drawings in accordance with PCI Drafting Handbook – Precast and Prestressed Concrete MNL-119
Registered Engineer	Currently registered professional engineer experienced in the design of precast concrete (on staff or subcontract)
Detailing Management	Ability and experience drawing and checking shop and erection drawings using prestressed concrete members. Able to train and evaluate detailing personnel and subcontractors

Individuals performing QC tests must demonstrate that they are proficient and capable of sampling and testing PCC or aggregate, where applicable, in accordance with the associated test procedures and MDOT requirements prior to commencement of related work.

Update MDOT within 48 hours when there are critical personnel changes during MDOT project work and before the start of each project by 10 business days.

5.7 Management Review

The Supplier must document the process used to conduct management reviews at planned intervals. The purpose of this review is to continually improve the suitability, adequacy and effectiveness of the plant's quality system. Reviews may be scheduled throughout the year that address all the items at once or only selected items. Subjects may be chosen based on nonconformances, customer focus or other significance to the Supplier. At a minimum, each item must be addressed and documented at least annually.

The management review must consider and record the discussions and actions taken related to each of the following:

- The status of actions from previous management reviews.
- Changes in external and internal issues effecting quality.
- Information on the performance and effectiveness of the quality system, including:
  - Extent to which the quality objectives have been met
  - Process performance and conformity of products and services
  - Monitoring and measurement results
  - Supplier performance
  - External and internal audit results
  - Nonconformities and corrective actions
  - Customer satisfaction and feedback
- The adequacy of resources such as production equipment, structures and production areas, personnel certification or training, measuring and test equipment.
- Opportunities for improvement in process.

5.8 Quality Records

- Management review records
- Personnel certification and qualification records
- Job descriptions
- Documented evidence of qualification
- Facility plan

6.0 Specification Review

The first objective of a successful project management system is understanding the customer's project as defined by specifications, design drawings and general contract documents. The second objective is to translate the customer's project requirements to the Supplier's processes to deliver the project the customer expects. Describe how all applicable contract documents are thoroughly reviewed before a project is accepted.

6.1 Controlling Changes

Describe how changes to product requirements including design and development requirements are reviewed and changes are tracked to ensure full incorporation of the change into the processes affected.

Repeat the review process when contract requirements are revised by contract changes, clarifications from an RFI (request for information), a response to a Supplier proposal, or other

official communication from the customer's authorized representative. The Supplier must include a process to communicate changes to responsible personnel.

Re-review is required only for areas affected by the changes which must be incorporated into the Supplier's project planning. For example, changes might include finish on a product, load a product is required to carry, location of embedded items, or openings.

Address these specific documents/criteria:

- Contract documents (design drawings and specifications, special provisions and documented communications)
- Addendums, change orders and plan revisions
- Source of the change
- Documents and procedures affected
- Communicate changes to all applicable parties and data bases
  - Transmittals from the owner or contractor
  - Owner responses to RFI
  - Responses to Supplier proposals
- Delivery schedule, including incentive and disincentive clauses

Show how project specification review is conducted for each MDOT project. Design the review to identify and address critical project requirements that may impact project quality and schedule.

6.2 Notification to MDOT

Describe the plans for transmitting information and records (including purchasing data such as POs, MTRs and other documentation) to the Engineer or QAI (as appropriate).

Identify the personnel positions responsible for these records and creating timely transmittal targets.

Describe how the Supplier assures that the Engineer is provided with a list of subcontractors including fabricators, galvanizers and painters. Include addresses and a list of products they will provide.

Commentary: Refer to the official MDOT correspondence on the use of the Material Source List dated 13 March 2014 for details on this requirement.

Before work begins, determine the means of communication with the Engineer and Contractor representatives as part of the contract review. Record contact information for the Engineer and Contractor representatives and any specific communication requirements mandated by contract documents.

At or before the review, identify a project manager for all communication with the Engineer and QAI.

6.3 Specification Review Record

Show in a specification review record how these items were reviewed. A detailed description of these items is included in the following sub-sections:

- Decisions and Actions
- Request for Information and Proposals for deviation from contract requirements
- Purchasing
- Design
- Detailing
- Submittal and acceptance/review by contractor or owner
- Material identification and traceability

- Fabrication/manufacturing process
- Inspection
- Training and qualification

6.4 Quality records

- Change log (optional)
- RFI log
- Record of specification review

7.0 Design and Detailing

7.1 Design Procedure

Develop, document, and implement an effective procedure to perform effective and consistent reviews of prestressed concrete beam designs and to prescribe or approve methods and procedures for:

a.) Tensioning

b.) Computations and measurements for elongations

c.) Measurements for camber and deflections

d.) Compensation for operational stress variations, and

e.) Any other functions related to prestressing that may affect the quality of the product

Include provisions for initial establishment and controlled modification of concrete forms and tensioning beds. Identify and define the responsibility for analysis; the Supplier must ensure the bed can handle the geometric constraints (number and arrangement of strands), and the forces resulting from tensioning the strands in a particular beam design. Address the requirements for verifying completeness of the modifications, including inspection and documentation.

Ensure there is an available registered design professional experienced in precast concrete design.

7.2 Detailing Procedure

Develop, document and implement an effective procedure to control how fabrication details are created and how they communicate project requirements. Address how the review, generation, revision, approval, control and issue of shop drawings are accomplished and documented. Include responsibility for the management and functions of this element, as well as the responsibility for specific tasks, including but not limited to:

- Ensuring that detailing procedures are followed
- Internal shop drawing review
- Drawing template approval by MDOT as part of the MDOT Shop Drawing Template Program and use prior to starting detailing
- Drawing submittals and owner responses
- Documentation of drawing changes
- How drawings are standardized (use of a detailing standard)
- How drawings are released to production and inspection and revisions are controlled

7.3 Quality Records

- Design/Drawing Submittal Log (or similar)
- Design/Drawing Change Documentation
- Drawing Release for Production Log (or similar)

8.0 Quality Document Control

Develop, document and implement an effective procedure to control documents and data affecting the quality and conformance of the processes and products.

The document control system addresses the QMS Documentation and customer contracts and communications. The Quality Manual, Project Drawings, standard procedures and work instructions are examples of QMS documentation.

Describe how applicable Quality Documents and Quality Records are readily available to personnel who have responsibility in the QMS, either in hard copy or electronically.

Describe how each quality document is identified and maintained so that it is used properly by the right personnel.

Maintain a revision history page or other suitable method to identify changes to the QMS and approval dates for changes to the QMS.

8.1 Forms

Control blank forms with a revision date. Require that a management representative controls a master list of forms. Consider including on blank forms information that instructs the user how to complete the form or what information needs to be captured, entered and analyzed.

8.2 Transmittals

Address how quality documents, submittals, records and other project correspondence are controlled and distributed outside of the company using transmittal systems. Include how revisions are controlled with this system. Include methods for transmittal to owners, clients, subcontractors and vendors.

Define how required documentation (copies of POs, MTRs, or other documentation required by the Engineer) is made available to the QAI in a timely manner so that inspection or review requirements do not impact project schedules.

8.3 Master List of Quality Documents

List all documents comprising the QMS by document name and revision date or level and assign responsibility for updating the list. Include the quality manual, any separate documented procedures and quality records identified in each procedure and section of the manual.

8.4 Contract Document Control/Log

Maintain a master log of contract drawings and specifications by project and assign responsibility for updating the log. Include document names and revision dates or levels. Use transmittals to track internal distribution of these documents and define distribution lists.

8.5 Fabrication Drawing Control

Maintain a master list/log for tracking shop or erection/installation drawings produced by the Supplier by project and assign responsibility for updating the master list. Include approval process dates and record the dates issued to production. Use transmittals to track internal distribution and define distribution lists.

8.6 Quality Records

- Transmittal
- Master List of Forms
- Master List of QMS Documents (may be combined with Master List of Forms)
- Contract Document Master List
- Fabrication Drawing Master List (may be combined with Contract Document Master List)

9.0 Quality Record Control

Define and document methods for the control of quality records. Provide for the following elements of control for quality records:

- Identification
- Collection
- Storage
- Maintenance
- Retrieval and backup of electronic data
- Retention
- Disposal

Retain project quality records for at least the project completion unless a longer duration is specified in the Supplier's QMS or contract. Retain other quality records that are not project specific as defined by the Supplier or as specifically noted in this Standard.

Ensure all quality records are legible and are stored in such a way that prevents damage, deterioration, or loss. Records may be electronic, hard copy, or a combination with appropriate controls described in the procedure.

10.0 Purchasing

Develop, document and implement an effective procedure to define purchasing requirements. Ensure that all purchased products, materials, services and subcontractors that have a direct impact on quality conform to project requirements.

Describe the internal controls regarding material ordering.

10.1 Purchasing Documents

Describe the effective use of purchasing documents that clearly describe subcontracted work purchased products, materials and services. Purchasing documents may be POs, material requisitions, purchasing agreements, but they must be documents. They may support the requirements for verbal orders made later against the technical agreement in these documents. These documents are accepted by the vendor to apply to the technical requirements for the items and services they supply. The document must include at a minimum:

- Buy America requirements for rebar and other steel products
- Material to be ordered by ASTM requirements
- Quantity to meet contract requirements
- Date of delivery
- Delivery instructions
- Requested Certificate of Compliance that must list the following:
    - Products are made and manufactured in the United States of America
    - Compliance with ASTM manufacturing requirements (MTRs)
    - Quantity not included in shipment communicated on shipping ticket/BOL (backorder info)

Documents for purchasing services such as design, detailing and engineering services.

- Minimum personnel qualification/certification requirements that meet MDOT requirements
- Must have documented experience in precast concrete
- Must meet requirements of PCI MNL-119 and MDOT (for detailing)

10.2 Evaluating Vendors

Describe the methods used and responsibilities to evaluate and approve new vendors and subcontractors before they are permitted to furnish any product or service. Evaluate new vendors based on an on-site visit, references, reputation, facilities and equipment, work samples, or possessing the necessary certifications and capabilities for supplying goods or services. Capture and maintain a list or database of qualified vendors that become your Approved Vendor List (AVL). Describe methods for how the vendor ranking or approval status on the AVL is determined and scheduled for periodic review.

Evaluate all vendors and subcontractors at least annually and more frequently if job conditions change or products and services are questionable.

Consider:

- Quality of the finished products; [may include adherence to specifications/drawings/quality requirements; Accuracy of product in size, marking, condition and appearance; Accuracy of support documents (test reports, certificates of compliance, etc.)]
- Delivery of products in accordance with schedules (on time) and in a proper manner (protected, arriving with proper certs, in required condition, from MDOT approved vendors when required, and other requirements as specified in the PO.)

Records Include:

- POs, purchase agreements or other document that defines the requirements of the product or service purchased. These are written contracts with a stated technical standard for the material, product or service to be purchased.
- Approval record and any applicable documentation that goes with the agreements;
- Qualification records, such as supplier certificates, personnel certificates, etc. for every requirement per the Supplier's certification
- Records of any necessary actions based on the Supplier's evaluations of vendors.

10.3 Purchasing Quality Records

- POs
- Subcontractor waiver from customer
- AVL or similar listing and a record of review
- Subcontractor and vendor qualifications and evaluations.
- Current certification records of subcontractors

11.0 Identification and Traceability

Develop, document and implement an effective procedure for the identification and traceability of materials, fabricated sub-products and final products. The procedure describes how the Supplier assures appropriate identification by specifying at the purchasing process and assuring and applying at the receiving process. The procedure also describes how the identification is marked or maintained from the point of receipt to the point of incorporation and then delivery to the project. The process must assure incorporation of the correct materials into the product and enable MDOT to trace the materials to the product at the levels specified.

Inspection at receiving is a critical part of providing traceability, particularly documenting receipt of materials and review and filing of vendor-supplied documentation. Evaluate vendors on the

completeness and accuracy of the documentation they supply with their materials, products and services. Include in that evaluation how well received items are marked.

11.1 Product ID

For finished product, document how each finished prestressed concrete beam is uniquely marked and dated to confirm production and to link the product to the specific conformance testing by the Quality Control Department and to raw materials or assemblies used in its manufacture.

Describe how the unit number and date will link to a production schedule and to in-plant quality control records. Describe how the mark number also links the product to the erection plan. These mark numbers and dates can be marked on the product or cast-in using specific date stamps, piece marks, and/or form numbers.

11.2 Raw Material ID

For bulk materials such as cement, aggregates and admixtures, an inventory system of dates received, dates placed into production and date of next shipment can provide the needed traceability.

Describe how these items and resources are used in the procedure:

- Ticket submittal for project
- MDOT Material Source Guide (MSG)
- MDOT Material Source List Form 0501: Use to record project materials, source of material, basis of acceptance, quantities, and type, size, or class.
- In such a way that testing required for each material type can be completed per MDOT specifications.

11.3 Reinforcing Bars

Identify rebar shipments at receiving in a way that will assure that material purchased for the project is used for that project. Train personnel in special handling for epoxy coated product to prevent damage to the coating.

11.4 Fabricated Metal—Supplier

Steel must be supplied per ASTM specified on approved shop drawings. Material test reports (MTR) must be provided traceable by heat number and be able to demonstrate Buy America status. Raw materials must be identified at receipt and maintain identification until the first fabrication operation. There must be an effective method to later connect the MTRs with the shipment to MDOT. Supplier must provide assurance of conformance to CRSI Code of Standard Practice if cutting or bending reinforcing steel.

Identify the WPS and welders used for the project. Include WPS(s) and WQTR(s) with the submittal.

11.5 Fabricated Metal—Vendor

Through POs or purchase agreements, the Supplier requires that the vendor identify finished pieces (part number, PO number or other suitable marking or tagging) so that MTRs can be assigned appropriately to the submittal package. Require current welding procedures and qualified welders to perform the work per *AWS D1.1 Structural Welding Code—Steel* for structural steel shapes and per *AWS D1.4 Structural Welding Code—Reinforcing Steel* for welded reinforcing bar products.

It is not required to use an MDOT shop that is participating in the quality program requirements program. Using a qualified shop also does not relieve the Supplier of the need to qualify the vendor. The selected vendor must transmit current welder qualification test records (WQTR), welding procedure specifications (WPS) and MTRs that support the delivered work. Vendor must

provide assurance of conformance to CRSI Code of Standard Practice if cutting or bending reinforcing steel.

11.6 Customer Supplied Material

Establish a method for identifying and controlling materials received from the customer intended for inclusion in the fabricated product. Address both materials ordered to specification and materials not ordered to specification; define documentation and identification requirements for both situations. Include provisions for ensuring the materials are correct such as written details/instructions from the customer, including MDOT acknowledgement where applicable.

11.7 Quality Records

- Vendor Delivery Tickets
- MTRs
- Certificates of Conformance
- MDOT Material Source List (Form 0501)

12.0 Fabrication Process Control

Establish documented procedures that address the controls necessary for these production processes at a minimum:

- Fabrication and welding of metal components
- Form loading and strand tensioning,
- Concrete production and placement,
- Transfer and stripping,
- Final curing and finishing, and
- Equipment maintenance.

Define workmanship standards for production with emphasis on concrete consolidation and consistency of product finish.

Define controls for preventing the use of materials prior to acceptance testing which is described in the inspection procedure.

Work instructions providing step-by-step guidance to production personnel are also expected for using production equipment, performing specific tests, defining workmanship standards, using work orders and creating and maintaining personnel qualification records at a minimum.

12.1 Form Loading & Strand Tensioning

Procedures for loading forms must address the following:

- **Casting bed and forms** – Describe the process of verifying casting bed and forms will produce the required shapes and pretensions. Include control of casting bed design and modification, inspection and maintenance of live and dead ends and verification of dimensional accuracy and readiness (release agents, surface quality, etc.) of the forms.
- **Placement of reinforcing steel and hardware** (reinforcing steel, welded wire fabric mats, supports and spacers, inserts, embeds, positioning frames, etc.) – Describe the method of ensuring only specified materials (raw and fabricated) and correct quantities and locations; i.e. using checklists, or marking on shop drawings or other production records, or other means. Address mechanical splices, verification of minimum concrete cover and intentionally extended bars.
- **Fabrication/welding** – Include welding consumable control and stud welding – see 12.5 for details

- **Stringing and tensioning strands** – Describe the procedure for stringing strands and establishing initial tension. Address selection and staging of strand coils or reels, strand chucks and strand debonding. Include provisions for ensuring tensioning equipment readiness (controlling jacking forces and ensuring gauging systems and controls are operative), identifying required tensions and sequence, recording data and making corrections. Describe the method of measuring force.
- **Final tensioning** – Define the method of applying final tensioning. Address equipment operation, force corrections for losses, elongation measurement, elongation calculation and correction, provisions for single and multiple-strand tensioning and provisions for harped strands.

12.2 Concrete Production and Placement

Procedures for concrete production and placement of concrete must address the following:

- **Developing Mix Design and JMF** – Describe the method of defining concrete mix design performance characteristics in terms of mixture properties (strength, slump, air content and unit weight) and how the characteristics are based on selected materials, performance requirements, environmental exposure considerations and placement restrictions such as method and reinforcing openings. Describe the testing required to qualify the mix design and establish the JMF according to one of the four methods of verification acceptable to MDOT (trial batches, same mix, similar mix, or annual verification); define the resulting mix documentation.
- **Batching and JMF Adjustment** – Document the procedure for adding precise proportions of constituents to a mix (batching), addressing the identification and selection of the JMF, the control and sequence of adding constituents and moisture control and compensation. The procedure must define control of the approved JMF and address maintaining and selecting approved JMFs either manually or through automated software. Describe how the JMF target weights (proportions) are adjusted and how the adjustments are documented. Include controls for limiting the water-cementitious material ratio (w/cm) for maintaining workability.
- **Production testing of components and of mix** – Describe the production controls for preventing placement of nonconforming concrete. Include provisions for communicating with quality control and following the ITP established for the project. Describe the method of sampling fresh concrete for the required testing.
- **Mixing and transporting concrete** – Describe the method of mixing including equipment and controls and measurement and limits of mixing times or rotations, addressing cold and hot weather mixing.
- **Placement and consolidation** – Describe the method and equipment used to place fresh concrete addressing prevention of aggregate segregation and compensating for severe weather. Include provisions for consolidation including vibrating equipment used (internal vibrators, external form vibrators, surface vibrators or vibrating tables, consideration of epoxy-coated rebar and method of inserting internal vibrators.

12.3 Transfer and Stripping

Procedures for transfer and stripping beams from forms must address the following:

- **Initial cure** – Describe the method of establishing and monitoring initial curing after concrete placement. Include provisions for temperature requirements, moisture sources or retention, use of membrane compound and accelerated curing if used.
- **Transfer break testing** – Describe the controls for preventing early detensioning of the strands prior to achieving required transfer strength, including specific communication between production and quality control.
- **Detensioning/releasing strands** – Describe the equipment, method and sequence of releasing strands after achieving the required transfer strength. Address single-strand and multi-strand release and include provisions for harped strand as applicable. Include provisions for protecting strand ends and anchorages from moisture penetration. Ensure the stripping procedure includes consideration of removable inserts, fasteners and form parts and defines methods of identification and lifting.

12.4 Final Curing and Finishing

Procedures for finalizing the prestressed concrete beams must address the following:

- **Yard storage and final curing** – Describe the storage of prestressed concrete beams during final cure including support locations, coverings and monitoring curing conditions.
- **Handling and shipping strength** – Describe the method of determining handling and shipping strengths for prestressed concrete beams when these requirements are not provided by MDOT. Include provisions for preventing handling and shipping until required strengths are achieved.
- **Finishing and sealing/coating** – Describe the methods and equipment used to finish concrete products, such as retardation, sandblasting, acid washing, debonding agents, or coatings/sealers.
- **Repair** – Prepare written repair procedures for non-structural repairs. Address curing and application requirements for repair materials.

12.5 Fabrication and Welding of Metal Components

This includes in-house fabrication of reinforcing steel included in the prestressed concrete beams and structural steel components such as external connection angles, braces and diaphragms.

Address cutting, bending and tying of rebar products. Include provisions for zinc and epoxy coatings such as special handling methods or equipment and repairs.

Describe methods of ensuring welding procedures, equipment and welding performance are in accordance with project requirements, especially the referenced AWS welding code. Include maintenance of assembly/fit-up tolerances, preheat or interpass temperatures, welding electrode control and atmospheric conditions. Procedures for welding headed studs and deformed bar anchors must include both automatic stud welding equipment and alternate processes such as SMAW, GMAW or FCAW.

12.6 Equipment Maintenance

Establish a preventative maintenance program for plant equipment that may affect quality. Equipment must be uniquely identified. Provide schedules for inspections and activities and include work instructions and provisions for recording completion and comments for each inspection or activity. Include forms, strand chucks, batching equipment, concrete mixers, admixture dispensers and concrete transport equipment such as trucks.

12.6.1 Form Verification

Form verification and maintenance can be addressed here or in another procedure as the Supplier decides is appropriate. Address how the form surfaces and dimensions are verified in detail after form construction or assembly before the first unit is cast, and after any modifications. Describe the program that assures forms are cleaned and maintained in a manner consistent with project requirements. Include the verification and maintenance necessary for bulkheads, templates, and similar equipment. Include the performance of maintenance inspections for all anchorage locations on the form for holding cast-in place materials are inspected for wear.

12.6.2 Quality Records

- Records of equipment maintenance

13.0 Inspection

13.1 ITP

The Supplier needs to follow an inspection and test plan or ITP to ensure all criteria defined in the scope of the project are satisfied. The ITP will help assure that the requirements of the Contractor Administered Quality Control Plan required in MDOT 12SP-708C are met.

13.1.1 Planning Inspections and Tests

Required inspection hold points for either QC or QAI may be based upon the Supplier's typical procedures or established specifically for MDOT projects. Information is also gained in communicating with MDOT on project specific interests. Additional points may be necessary depending on project complexity.

Submittal of the ITP is not required, but the Supplier is responsible for reviewing and updating it based on the requirements for each project. Refer to the MDOT Prestressed Concrete Beam Fabrication ITP Sample in the Annex of this Standard for assistance in development. This sample format and content is non-mandatory. The Supplier must develop a suitable format and content to meet specific project requirements and to function appropriately in their company. Discussion of hold points may occur during prefabrication or preconstruction meetings when required by contract.

See Figure 2 in the document annex for a sample of this mandatory requirement. The sample is comprehensive. A Supplier's ITP may be less comprehensive and have more or less specific project related requirements.

The ITP provides a basis to communicate and record:

- The inspection points and characteristics inspected (as detailed in the in-process inspection procedure)
- The frequency required for the inspections and tests
- Supplier personnel responsible
- Process control limits (QC Action Limits)
- Acceptance criteria (QC Suspension Limits)
- Hold points where either the QAI or QCI documents acceptance prior to subsequent processing steps

13.1.2 Coordination with the MDOT Shop Inspector

Establish a method for communicating with the MDOT QAI. It is essential that both Supplier and MDOT inspectors coordinate hold points such as witnessing production or quality control activities, verifying documentation, performing verification inspections or tests, or other activities that could impact schedule.

Address the responsibility to directly communicate production and quality control schedules and updates so that MDOT QAI can honor both their QA obligations and the schedule as much as practical.

MDOT QAIs must be notified of all production and quality control activities; they may consent to the Supplier proceeding without their presence or may request to be present for more than the minimum required number of hold points. Last minute changes should be avoided.

Include provisions for documenting requests for inspections or notifications of specific activities requiring MDOT presence. Ensure the method requires written acknowledgement by the QAI and captures any waived hold points or requests to be present for additional activities beyond the ITP.

13.2 Inspection and Test Status

The procedure must address how the Supplier marks or identifies the inspection and test status of in-process and completed product. The method must be consistent and understood among inspection personnel and the status must be clear to production personnel. The method may be markings or tags on the product or materials, records (accessible hard copy or electronic) that record the current status or a combination. Marking or recording must be updated as soon as possible to protect the process. Status milestones include conditions met or pending such as received, dimensional, waiting for test results, ready for patching or finishing, or under evaluation from the owner for resolution of a nonconformance.

13.3 Inspections to be Completed and Documented

13.3.1 Receipt Inspection/Acceptance Testing

Describe how materials or assemblies are received and verified to conform with the technical requirements of the POs or purchase agreement standards. Those requirements may be referenced by a standard record form. Tickets for bulk products such as aggregates and cement can be marked so they are immediately identified as having been reviewed for conformance and resolved.

Describe the method of acceptance of all constituent materials prior to use or shipment including cement, aggregates, water, admixtures, curing materials, release agents, surface retarders, debonding agents, weatherproofing sealers, reinforcing and prestressing steel, hardware materials and vendor-supplied assemblies. Certificates are not always available for all materials; describe alternate testing to be performed for each material.

13.3.2 In-Process Inspection

Document a procedure that identifies the in-process inspections necessary to ensure product quality. The procedure may reference the ITP for specifics. At a minimum, define the characteristics inspected, frequency or sampling plan and the means of recording acceptance for the following inspections:

- Tensioning inspection – indicate QC activities performed during initial and final tensioning
- Fabrication inspection – indicate QC activities performed before, during and after structural steel, rebar and hardware fabrication
- Pre-placement inspection – indicate characteristics inspected just before concrete placement; QCIs verify set-up details including form conditions, overall lengths, widths and depth, end details, strand deflection points, reinforcing steel material and locations, plates (material and locations), block outs, inserts and lifting loops
- Post-placement inspection – indicate characteristics inspected just after stripping

13.3.3 Final Inspection

All products must be inspected prior to shipment. The inspection procedure must define the characteristics to be inspected, acceptance criteria, when the inspection must be performed, the qualification requirements of the final inspector and how the final inspection status of each product will be identified and documented; it may reference the ITP for specifics. Tolerance for dimensional control is either defined in the project requirements or consistent with PCI MNL 116, Appendix B.

The procedure must describe measurement methods and instrument/equipment precision.

13.3.4 Tests

List the tests performed (may reference the ITP) and reference work instructions or other documents that assure staff is performing tests consistently and in accordance with MDOT and PCI MNL 116 requirements. Identify the position with the responsibility to describe, design and supervise tests. Include test types, frequency, sampling plans and recording methods that are used at the facility.

A sample list of tests that may apply to materials:

- Cement (in the absence of mil certificates)
- Aggregate tests (coarse and fine)
- Water
- Admixtures (review of supplied certification)

…and tests related to production QC:

- Slump

- Air content
- Temperature
- Unit weight
- Concrete strength

13.3.5 Mix Design Certification

Mix designs and their accompanying JMFs must include a statement, signed by a certified PCC technician (MCA Michigan Level II or PCI Level III), that all applicable standard test methods have been followed in verifying the mix design and JMF.

Identify the responsibility for creating this record and determine a sample for personnel to use to promote consistency in presentation.

Describe the procedure for documenting a request for variance when proposing a mix design that does not meet specified contract requirements.

13.4 Inspection (QC) Records

Describe the process to maintain complete records of all QC tests and inspections. Include enough information to allow the test results to be correlated with the items of work represented. Document what action was taken to correct deficiencies. Furnish one copy of all QC records, including test reports for the fresh PCC placement, to the Engineer within 24 hours after the date covered by the record in a format acceptable to the Engineer. The Engineer may withhold acceptance of the products for failure to provide properly documented and timely QC records and reports

13.5 Quality Records

- ITP
- Tensioning Record
- Concrete Batching Record
- Fabrication Record (structural steel, rebar, hardware)
- Pre-concrete placement Inspection Record
- Post-concrete placement Inspection Record

14.0 Control, Calibration and Maintenance of Inspection, Measuring and Test Equipment

Develop, document and implement an effective procedure to control, calibrate and maintain inspection, measuring and test equipment used to demonstrate that products and processes comply with specified requirements.

14.1 Equipment Listing and Identification

Identify the gages and equipment measuring devices that are used to demonstrate the conformance of product, or gages which provide direct process measurements that determine product compliance.

Create an equipment list that provides a means for unique identification of each piece of equipment. Each piece of equipment will bear a unique identification "mark", serial number or a precise description that ties the equipment specifically to the list and the calibration log. Calibration for each device may vary depending on manufacturer's requirements and use in the plant. Calibration frequency is at least annual. Specify the accuracy required.

Calibration of the batch plant is required semiannually. Identify what level of authority is required – under the supervision of a licensed engineer for example.

Sample:

Tool	Calibration/Verification Frequency	Accuracy Required	Source
Tensioning Jack #5 Ram Serial #xxxxx Jack Serial #XXXX	Monthly	loads are within 2% of gauge	Internal Load cell # xxxx

Note: Typical list of items that maybe on a calibration list for a Supplier in an onsite batch plant:

Batch Plant:

- Coarse Aggregate Feed Hopper Weigh Belt*
- Coarse Aggregate Moisture Gauge
- Fine Aggregate Feed Hopper Weigh Belt*
- Fine Aggregate Moisture Gauge
- Fly Ash Feed Hopper Weigh Belt*
- Mixer Feed Weigh Hopper*
- Water Feed Meter
- Admixture # 1 Feed Meter**
- Admixture # 2 Feed Meter**
- Admixture # 3 Feed Meter**
- Admixture # 4 Feed Meter**

QC Test Area:

- Air Test Pot Gauge (pressure/vacuum)
- Compression Test Force (Pressure) Gauge(s)Scales (used for determining density)

Production Equipment:

- Pre-Tension/Final Tensioning Force (Pressure) Gauge(s)
- Measuring devices (scales, tapes, etc.)

*May be one, two, or three depending upon Batch Plant configuration

**May be as many as eight (8), depending upon Batch Plant configuration

14.2 Calibration Procedures

Develop a calibration work instruction or procedure that identifies the plan testing parameters, calibration/verification frequency, the accuracy required and if the calibration is done internally by Supplier personnel or by an external source. Include the points where checks are performed in the testing parameters. That could be points of pressure, location of sampling or other appropriate sampling method to assure calibration accuracy throughout the full range of the use of the equipment.

14.2.1 Internal Calibration Procedures.

Describe the qualification required for internal personnel to perform the work and that calibration equipment or master gages needed to perform the work is traceable to a national standard. Describe any stamp or license necessary to be qualified to perform calibration testing.

Identify master gages in a log or list. A master gage is a gage that is purchased and traceable to a national standard, typically from a gage supplier who also supplies documentation (certification of conformance) certifying traceability. Choose what master gages are necessary to calibrate gages used in the scope of supply and demonstrate traceability to a national standard.

14.2.2 External Calibration Services

Assure that external sources are qualified by the Purchasing function or other designated professional. Identify the laboratory, agency or certification required by that source to perform the work. Obtain the agency's testing procedure that identifies any testing standards (AASHTO or ASTM) that must apply to the operation. A testing certificate or report may be all that is needed to identify the test parameters.

14.3 Calibration Log or Calibration Records

Detail the responsibility for maintaining records and identification on gages. Show in a calibration log or other suitable record:

- Gage (description)
- Gage identification
- Specific frequency of calibration
- Accuracy required
- Measurements to be taken
- Actual measurements
- Standard used for calibration
- Date of calibration
- Next due date

14.4 Quality Records

- Calibration certificates of conformance
- Calibration Log/Record
- Personnel qualification licenses or documents

15.0 Control of Nonconformance

Develop and document an effective procedure for recording and controlling nonconformances.

15.1 Nonconforming Processes

Process nonconformances are deficiencies in methods reflected by recurring errors and negative trends in the performance of the QMS. These can be process or system nonconformances in support processes (like detailing, contract review, purchasing, generation of CAD data) and operational functions (like CAD directed equipment, faulty consumables, uncalibrated equipment, poor electrical connections, or consistent human error due to lack of training).

15.2 Nonconforming product

Product nonconformances are deficiencies in products or materials that do not conform to contract plans, shop drawings, NDT procedures, customer intended use requirements, applicable code requirements, or company requirements

PCI suggests categorizing product nonconformances that need repair as nonstructural cosmetic-two levels; and structural nonconformance-two levels, standard (minor) and nonstandard (significant).

15.3 Nonconformance Log and tracking

15.3.1 What to Record

Record and track nonconformances in reports and/or one or more logs of a desired format.

Define what will be recorded, but include the following as a minimum:

- The pieces affected,
- the nature of the nonconformance,
- disposition of affected items still at the Supplier or already shipped, and
- potential ramifications for similar items on previous projects.

15.3.2 Recording Re-inspection

When nonconforming product is repaired or reworked, it is subject to the original inspection criteria; record the results, including the inspector who made the re-inspection and date of acceptance. Link the new record to the original deficiency record if they are separate documents in your system

Include other pertinent information to periodically track and analyze nonconformance trends and recurrence rates.

15.3.3 When to Record

Clearly define the threshold for recording a nonconformance. For product nonconformances, consider basing it on structural severity, costs, time to correct, or other criteria appropriate to your organization.

Process nonconformances may have similar criteria and may be based on significance. However, they are often recorded regardless if only one occurrence is found. A single nonconformance in a QMS process typically indicates only the tip of the iceberg. Waiting for more of the same process nonconformances may expose the process to many more multiple errors.

15.4 Significance

A nonconformance can be considered significant if it is associated with a defect that jeopardizes the safety, functionality, ease of erection/installation, and/or serviceability of the structure. This may include improper material, numerous or repetitive nonconformances, significant dimensional errors, deficient weld properties, or incorrect joints and connections.

15.5 Quality Records

- Nonconformance Report or Log (Supplier Form)
- Nonconformance Report (MDOT Form)

16.0 Corrective Action

16.1 General

Not every nonconformance is considered for corrective action. Identify the responsibility in the organization that evaluates the issue and decides if a CAR will be issued. Issue CARs by looking at summaries of product nonconformances, the results of QMS audits or noted as a regular course of business.

Describe the methods and responsibility to close CARs after evaluating the root cause and implementing the actions developed to prevent recurrence. After the selected actions are taken, verify the deficiency has been corrected to close the CAR. Schedule a re-audit after an appropriate interval to assure continued effective implementation.

16.2 Causes for Corrective Actions

- Significant nonconformances
- Product or process nonconformances are repetitive

- Undesirable conditions affecting productivity, employee safety, customer relations, or other Supplier goals.
- Requests or complaints from an external source
- When performance indicator targets are not met

Invoke the corrective action system when nonconformances are identified during external audits by a customer or agency. The external source may require a response using their own formats, deadlines and requirements; the Supplier must enter the issue into the Supplier's system.

16.3 Recording and Tracking a corrective action activity

Develop a form, log, database, or other suitable method to record the required information for a corrective action. The method must clearly communicate the identification, actions and status of each activity. Ensure the system captures the following information:

reference	The reference or requirement that has not been met. This can be from a product deficiency, customer nonconformance report, internal audit finding, unsatisfied code, specification or contract requirement, or from the Supplier's Quality Manual and procedure documentation.
observation	The specific product issue/objective evidence item/observation that demonstrated noncompliance.
correction	Measures taken to eliminate or contain the specific nonconformance (if required)
responsibility	Identify the individual, manager or team assigned the responsibility for evaluating and addressing the situation as a QMS function
schedule	The timeframe for completion. Due dates for identification of root cause, analysis and action to prevent recurrence.
root cause	Identification of the root cause, including contributing factors to ensure appropriate corrective actions.
actions	Action to eliminate or control the causative factors and prevent a recurrence.
verification	Verification of implementation and effectiveness of measures taken can predictably lead to closure. When a corrective action is executed, conduct a follow up to verify it was implemented in a timely and effective manner and to ensure the steps taken continue to be effective in avoiding recurrence.
closure	Document completion of the corrective action process, including name and signature of the person verifying closure of the issue. Include any future plans to verify effectiveness.

16.4 Review and Monitoring

Identify the responsibility for maintaining the CAR system and monitoring the progress of closing the actions. Prepare a summary of closed and open CARs for assessment at management reviews of the quality system.

Perform adequate root cause analysis and reassessment after implementation of the fix.

Include any closed and open CARs in the scope of the internal audit of that element. This assures that the actions taken continue to be monitored for effective implementation.

16.5 Quality Records

- CARs
- Summary of corrective actions for management review

17.0 Handling and Storage

17.1 Planning and Execution

Develop storage plans for products indicating dunnage type and sizes and driving lanes for handling equipment. Describe the method of reviewing equipment capacity for lifting and handling, including assignment of responsible personnel. Include controls for ensuring conformance to the lifting points and equipment and support locations shown on the plant shop drawings.

Include provisions for performing and documenting regular product storage inspections and controls for preventing delivery of product which has not been final inspected. Describe the method of loading, including tying down loads and preventing application of unexpected loads to products resulting from improper loading.

17.2 Quality Records

- Project Storage Plan
- Storage Inspection Record (or similar)

18.0 Training

The Supplier must develop a program that defines the documented training requirements for each position. Informal training can be documented by a date or other mark in a table or other simple notation or database or list to assure that personnel at all levels have been informed and training on their responsibility for quality. Training programs define scope and frequency of the training. The program must address initial and periodic training, documentation requirements and special training requirements for quality control personnel.

18.1 Initial and Periodic Training

Ensure personnel responsible for the quality of products and services receive initial and periodic training in their specific job functions. Periodic training is expected whenever there is a change in specific duties or whenever a procedural change in a particular job is implemented, or when industry codes and specifications are updated, or customer requirements change. The Supplier must define the required training for each specific critical position in a procedure. The inspection and testing functions must be included in the defined training plan.

When required, conduct training by in-house qualified employees or by a qualified source or institution outside the company. Assure that the requirements for documenting training are met.

Describe provisions for ensuring personnel maintain understanding and describe how the program focuses on requirements that may be infrequent to the shop schedule. Special meetings, refresher training and specific quality plans may be necessary for jobs or activities that are not part of the Supplier's daily work routine.

Specific training requirements may be detailed in Supplier specific supplements.

18.2 Documentation Requirements

Documented training differs from informal training because it requires training records. Training records include instructor, attendees, course outline and date and an evaluation of attendee comprehension. Include supplemental documentation such as training hand-outs or slides to demonstrate meeting specific subject requirements.

18.3 Quality Control Inspectors

Document training records for inspection personnel. Review the knowledge and qualifications of inspectors periodically to ensure compliance to job qualification specifications or industry code requirement changes. Develop an outline of training requirements by verification activity, listing the activity, the position assigned and the required training or certification. Required training must be defined in terms of topic and frequency.

18.4 Quality Records

- Training Record (for training performed by in-house instructors)
- Certificate of Completion (for training performed by hired instructors or firms)
- Quality Control/Verification Personnel Training Requirements Outline

19.0 Internal Audit

Describe in a procedure how internal audits of the QMS are conducted. Audit the requirements of all clauses of this standard at least once a year to verify compliance and effectiveness.

Conduct audits of the entire system at one time, or schedule recurring audits to cover different parts of the system throughout the year. Sections may be scheduled for convenience or by critical importance to the QMS. Identify which personnel are assigned to perform the audit or portions of the audit and how they are qualified to conduct audits in areas other than where they work. Ensure auditors are independent of the functions they are auditing, except for the Executive Manager representing the QMS.

Show in the record generated what elements were audited. Review the results of the audit with the management personnel responsible for the efficient operation of the audited element or function.

Address how nonconformities are noted during the audit and how they are evaluated to be considered for corrective action. Initiate a corrective action depending upon the severity, frequency and importance of the nonconformity.

19.1 Quality Records

- Record of internal audit results
- Internal and external QMS audit records

20.0 Annex

This Annex is published in a separate document in larger format for easier reading.

20.1 Severity of nonconformance during MDOT audits

This is part of the mandatory program rules and supplements J. Nonconformance

Figure 1 – Severity table for nonconformances found during MDOT audits. Referenced in Section N of the main SQS document.

	Critical	Major	Minor	Concern
Definition	Issues which directly affects and severely reduce the quality and acceptability of the product, possibly leading to premature failure, excessive maintenance or diminished service life. This may include but is not limited to the use of defective material or consumables, unauthorized modifications or substitutions, practices violating code or specification requirements, falsification of any record, absence of proper documentation for critical items and unqualified individuals performing critical tasks.	Issues related to the Quality System, which directly or indirectly affect production dependability and consistency, potentially leading to reductions in product performance, quality and reliability. These nonconformances could result in schedule delays, repairs and shortened service life. This may include employee inability, missing procedures, poor equipment condition, material quality, drawing accuracy, vendor services and supervision.	Issues related to documentation shortcomings, or other minor infractions within the system application that are not expected to cause multiple nonconformities or significant product deficiencies in current or future projects. This may include insufficient calibration, inadequate training, specification not current, missing procedure steps and some illegible identification.	Concerns may be related to accuracy, consistency, individual actions or other issues that could impact product quality but do not yet constitute a nonconformance They may also relate to other products not covered by the audit
Supplier Response	If the NC is directly product related, ▪ Work is stopped on the affected product or portion of the product. ▪ Provide documented proposed correction to MDOT as soon as possible but within 7 days. ▪ Create a CAR and respond to the NC within 10 days after issue. (Include corrective action information in the CAR). Complete root cause analysis and determine actions to prevent recurrence and provide objective evidence within 14 days ▪ Potential revisit within 21 days ▪ Immediately implement 100% inspection of that product/component/process for the remainder of the project. ▪ If directed by MDOT, create a hold point for product/process within the project quality plan or a quality procedure and submit to MDOT. If the NC is system related, ▪ A CAR response proposing system changes will be required within 7 days. ▪ System changes, such as an updated/new procedure and QM will be required within 14 days to show how the system will be modified to resolve the issues. ▪ A full system internal audit must be completed with records of results within 30 days. ▪ A monthly internal audit focused on that program element must be completed with records of results until the next audit. ▪ Records to be submitted after every monthly internal audit.	Response to NC due in 14 days, closure by 30 days (MDOT satisfaction of the proposed actions to prevent recurrence). For the verification of effectiveness of **Major** NCs, forward supporting objective evidence to the MDOT Program Manager within 45 days of the receipt of the audit report from the state.	Response due in 21 days, closure by 45 days (MDOT satisfaction of the proposed actions to prevent recurrence). For the verification of effectiveness of **Minor** NCs, forward supporting objective evidence to the MDOT Program Manager before the next scheduled audit. A minimum of three months in advance of the next onsite audit is required to assure any ambiguities observed in the Suppliers CAR response are taken into consideration and addressed prior to that audit	No response is required externally, but the Supplier is expected to review the concerns and discuss internally. Concerns which relate to product quality but do not yet constitute a nonconformance may be elevated to NCRs in future audits if not addressed. They may also call the Supplier's attention to operations that could be improved, benefitting the Supplier and their customers.
MDOT action	The MDOT program manager is informed and work on a current MDOT may be halted. MDOT must approve the proposed correction If verification of remediation is not successful: ▪ Supplier may be removed from the ASL ▪ Supplier will be listed as "Approved-Probation" on the ASL, with no future additional project negotiations until resolution.	MDOT reviews Supplier's CAR and may accept the plan and the CAR is considered conditionally closed, pending receipt of objective evidence. The plan is verified at the next SQS audit. It is expected that the CAR is closed successfully. Unsuccessful closure may result in a listing as "Approved-Probation" on the ASL and Third-Party Disciplinary action may be required.	MDOT reviews Supplier's CAR and may accept the plan and the CAR is considered conditionally closed, pending receipt of objective evidence. Minor NCs that remain open more than two audit cycles or which increase in frequency or severity are moved to major status	MDOT will not take any actions regarding Concerns, but the auditor will review them during the next audit
Audit action	Auditor calls the MDOT Program Manager and follows up with a confirmation email within 24 hours. Alternately, the call can go to one of the QAIs assigned to that Supplier.	Record on audit report		Record on audit report

20.2 Sample ITP

This is a comprehensive example to aid the Supplier in creating an ITP appropriate for their own supply. It is likely that the Supplier's ITP will be less comprehensive.

tem No.	**Inspection/Test Item**	Referenced Requirement	Acceptance Criteria	Code	QC Suspension Limits	QC Action Limits	Frequency	**Description**	Output / Record
	Hold Point Codes: **H = Mandatory Hold Point, Fabricator must notify Inspector and then Inspector must release the operation before the Fabrication can proceed** **W = Witness / Inspection Point sampling activity, prior notification by the Supplier (quality document required for Inspector activities of this type)** **R = Review of Required Documents for adequacy and completeness** **M = Monitor through routine observation of the Fabricator's Work Activities (See Annex at the bottom of the document for detailed description of "Observation")** **P = Perform (responsible for actual completion of the step)A = Approve/Accept to release a hold point**								
1	Plant Certification	MDOT 708.03.A.1	Per product type: B3 or B4 for bridge beams B4 for any draped strands B2 or C2 for miscellaneous or hollow-core	P			Prior to startup	**Immediately correct items that do not conform to PCI plant certification. Provide a copy of the certificate of conformance to the Engineer before beginning production. Display the certificate of conformance in each plant facility.**	PCI Certificate
2	Supplier's Quality Control Plan (Inspection & Test Plan or ITP)	12SP-708C-1.c.1	All procedures to control production and placement of PCC are identified, including when to initiate corrective Sampling, testing, and inspection frequency ensure conformance of work to specification requirements	P			Prior to startup	**Prepare, implement, and maintain a QC plan for PCC, in accordance with applicable plant certification requirements shown in the contract, which will provide quality oversight for production, testing, and control of fabrication processes.**	Approved QCP or ITP
3	Concrete Mix Design and Verification (PCC Mix Design & Job Mix Formula Testing)	MDOT 708-03.A.6 (12SP-708C-1.c.5.B)	Test Results: a. Air content of 5.0 percent to 8.0 percent, except as specified in item e; b. 28-day compressive strength as shown on the plans; c. Slump from ¾ inch to 2½ inches if not using water-reducing or retarding admixtures; d. Slump no greater than 4 inches if using a Type A or Type D chemical admixture; e. Slump no greater than 8 inches and an air content no greater than 8.5 percent if using a Type F or Type G chemical admixture; and f. At least 564 pounds of cementitious material per cubic yard of concrete. (Each JMF and referenced documentation individually identified.) (Each JMF identifies the associated method of verification)	P			Every 2 years each mix design (Each grade PCC for project)	**Design a concrete mixture meeting the requirements for air content, 28-day compressive strength, slump, and unit weight of cement per cubic yard.** **Provide cementitious material with fly ash content no greater than 25 percent of the total weight of the cementitious material. Provide slag cement content no greater than 40 percent of the total weight. If using fly ash and slag cement in the same mixture, do not exceed 15 percent fly ash and 25 percent slag cement.** **(Develop and verify PCC mix designs and JMFs, as specified in the 12SP-708C-1.c. Submit documentation to Engineer 10 working days prior to startup)**	Mix Design Record (MDOT JMF Concrete Field Communication Form 1976)
4	Alkali-Silica Reactivity (ASR) Testing	12SP-708C-1.c.5.A	Per Test Method used	P			Every 2 years each JMF	**Provide documentation to the Engineer that the PCC mixture does not present the potential for excessive expansion caused by alkali-silica reactivity (ASR). Provide current ASR test results (valid for 2 years from completion of testing), for the fine aggregate that is proposed to be used in the PCC, from an independent testing laboratory proficient in ASR testing.**	ASR Test Results Independent Test Lab Certification
5	Shop Plans (Shop Drawings)	MDOT 708.03.A.2	MDOT 104.02 Engineer's approval	P			Prior to startup	**Submit shop plans in accordance with subsection 104.02. Show complete fabrication details and initial prestressing forces. Send three sets of drawings to the Engineer for review and approval. Do not start production until the Engineer approves the shop plans.** **Show strand tensioning sequence on shop plans or other written submitted documents.**	Shop Drawings
6	Pre-Fabrication (Pre-construction) Meeting	MDOT MQAP 4.04.04.A	No open issues	P			Prior to startup	**Attend prefabrication meetings to facilitate effective quality control and quality assurance on the project. These are conducted by MDOT's Structural Fabrication Unit prior to the start of fabrication and preferably after shop drawings have been approved**	MDOT Meeting Minutes
7	Notice to Proceed	MDOT 708.03.A.3	Notice received on time	P			One week prior to production	**Notify the Engineer at least one week before beginning the manufacture of concrete beams**	Notice to MDOT (written)

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8	Annual MDOT Independent Assurance Testing (IAT)	MDOT MQAP 4.04.04.B	Related ASTM or ACI or MDOT Test Procedure	P			Prior to pouring concrete	QCI must pass annual MDOT independent assurance testing (IAT) proctored by the MDOT SFU prior to performing fresh concrete testing	MDOT Record
	MATERIAL ACCEPTANCE								
9	Materials Supplier List (MSL)	MDOT 105.01.B MDOT MQAP 4.04.04.B.2	Contract documents Minimum information per MQAP 1.04.02	P			At or prior to pre-construction meeting	Provide the required project-specific MSL to MDOT. The Michigan Department of Transportation (MDOT) is requiring a Material Supplier List (MSL) to be submitted for all MDOT and Local Agency projects with structural precast concrete elements. This requirement is effective for projects Let after April 1, 2014 and applies to all elements that require fabrication inspection as the basis of acceptance per the MDOT Materials Supplier Guide (MSG) or as determined by the Project Engineer.	Material Supplier List (MSL) – MDOT Form 0501
10	Notice of Material Delivery/Change of Supplier/Transfer	MDOT 105.01.C thru 105.01.E	Notice received on time	P			7 days prior to when material arrival	Notify the Engineer in writing, at least 7 days prior to when materials are required on site, that materials are ready for sampling, testing or inspection by the Department, including materials obtained from Department-approved certifiers or selected from the Department's Qualified Products List. Change the Supplier of supply only after providing the Department with a reasonable time to perform the required sampling, testing or inspection. Provide the required documentation and obtain written approval from the Engineer before transferring materials that the Department has accepted, for use on another Department contract	Notice to MDOT (written)
11	Material Acceptance	MQAP 4.04.04.B.3 and 4.04.04. G	Contract Documents RFIs	P			All component materials -	Inspect materials that will be used in the fabrication process and ensure they are being stored correctly, tagged for traceability purposes, and are in conformance with the contract documents	QCI Record
12	Material Verification – Portland Cement	MDOT 708.02 MDOT 901.03.A	ASTM C150 for Type I, II, and III Portland Cement ASCM C359 Mortar Method – no false set* Approved Manufacturer	P			Prior to concrete placement *Mortar test for premature stiffening during placement	Confirm Portland cement material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99 Provide the Engineer a copy of the Certification of Quality of Cement (Supplier's Report) as provided by the producer (ref. MDOT 901.01) Each shipment of cement shall be referenced to a certified mill test report that indicates compliance with the specified type of cement and ASTM C150. The producer shall maintain the test reports on file. (ref. PCI MNL 116-99 Section 3.1.2)	General Certification
13	Material Verification – Blended Cement	MDOT 708.02 MDOT 901.03.B	ASTM C 595 Approved Manufacturer	P			Prior to use	Confirm blended cement material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99 Blended cements must meet the requirements of ASTM C 595 Provide Supplier's certification per ASTM C595 (based on MDOT 901.01)	General Certification
14	Material Verification – Masonry Cement	MDOT 708.02 MDOT 901.04	ASTM C91 Type N, S, or M Approved Manufacturer	P			Prior to use	Confirm masonry cement material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99 Masonry cement must meet the requirements of ASTM C91, Type N, Type S, or Type M. Provide Supplier's certification per ASTM C91 (based on MDOT 901.01)	General Certification
15	Material Verification – Hydrated Lime	708.02 901.05	ASTM C207, Type S or Type SA Approved Manufacturer	P			Prior to use	Confirm hydrated lime material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99 Hydrated lime must meet the requirements of ASTM C 207, Type S or Type SA.	General Certification

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16	Material Verification – Slag Cement	708.02 901.06	ASTM C989, Grade 100 Approved Manufacturer	P			Prior to use	**Confirm slag cement material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99** **Slag cement must meet the requirements of ASTM C989, Grade 100, minimum** **Provide Supplier's certification per ASTM C989 (based on MDOT 901.01)**	General Certification
17	Material Verification – Fly Ash	708.02 901.07	ASTM C618 Class F or C loss on ignition must not exceed 5.0 percent meets air-entraining admixture uniformity requirement in Table 3 for Supplementary Optional Physical Requirements Approved Manufacturer	P			Prior to use	**Confirm fly ash material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99** **Fly ash must meet the requirements of ASTM C 618, Class F, or Class C, except the loss on ignition must not exceed 5.0 percent and the air-entraining admixture uniformity requirement in Table 3 for Supplementary Optional Physical Requirements will apply** **Provide Supplier's certification per ASTM C 618 Section 12.1 (based on MDOT 901.01)**	General Certification
18	Material Verification – Silica Fume	708.02 901.08	ASTM C1240	P			Prior to use	**Confirm silica fume material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99** **Dry-densified silica fume must meet the requirements of ASTM C 1240**	General Certification
19	Material Verification – Coarse Aggregates	MDOT 708.02 MDOT 902.02	Sieve Analysis and Loss by Washing per Table 902-1 Physical Tests per Table 902-2 Prequalified Aggregate Source	P			Prior to use	**Confirm coarse aggregate material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99** **Ensure natural coarse aggregate conforms to MDOT 902.02 6AA or 17A** **Test coarse aggregate per MDOT 902.02 – acceptance test every 1000 T for non-prequalified Supplier** **Ensure the bulk dry specific gravity falls within the limits established by freeze-thaw testing**	Aggregate Ticket
20	Material Verification – Fine Aggregates	708.02 902.08	Sieve Analysis, Loss by Washing, and Fineness Modulus Variation per Table 902-4 Prequalified Aggregate Source	P			Prior to use	**Confirm fine aggregate material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99** **Ensure fine aggregate conforms to MDOT 902.08 2NS** **Test fine aggregates per MDOT 902.02** **Ensure that, when tested for organic impurities in accordance with AASHTO T 21, the aggregate does not produce a color darker than Plate 3 (light brown), or otherwise approved by the Engineer.** **Uniformly grade the aggregate from coarse to fine in accordance with Table 902-4. Fine aggregate 2NS must meet fineness modulus requirements in Table 902-4.**	Aggregate Ticket
21	Material Verification - Admixtures	708.02 903 MDOT MSG	Max 0.5 % by weight chloride ion content for liquid chemical admixtures Physical properties and storage of latex admixtures per MDOT 903.03 Approved Manufacturer MDOT QPL	P			Prior to use	**Confirm admixture condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99** **Select air-entraining admixtures for concrete from the Qualified Products List (903.01)** **Select liquid chemical admixtures, including water-reducers, retarders, and accelerators, for use in Portland cement concrete from the Qualified Products List (903.02)**	General Certification
22	Material Verification – Prestress Strand	708.02 905.07	ASTM A 416, for Grade 270, Low Relaxation Strand MDOT Diameter and cross-sectional area limits of 905.07 Visual requirements of MDOT 708.02 Approved Manufacturer	P			Prior to use Each reel or pack	**Confirm strand material condition, storage, and identification meets MDOT 708.02 requirements and PCI MNL 116-99** **Strands for prestressed concrete must have a 0.500-inch nominal diameter and a 0.153 square inch cross-sectional area or a 0.6000-inch nominal diameter and a 0.217 square inch cross-sectional area and must meet the requirements of ASTM A 416, for Grade 270, Low Relaxation Strand, as required.** **Identify each reel or pack number and provide a Test Data Certification, including a load-elongation curve to at least 1 percent elongation.** **Protect prestress strands from physical damage, rust, and contaminants.**	Test Data Certification (including load-elongation curve to 1% elongation) General Certification

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23	Material Verification – Debonding Compound (finishing)	708.02	Debonding compound on QPL or DOT equivalent (1800 beams flanges)	P			Each delivery	**Select a de-bonding compound for prestressed concrete 1800 Beam Flange from the Qualified Products List, or provide a Department approved equal. Follow the Supplier's specifications and procedures for mixing the compound**	General Certification
24	Material Verification – Reinforcing Steel (General)	708.02 905.03	Applicable ASTM or AASHTO specification Approved Manufacturer	P			Prior to placement	**Confirm reinforcing steel material condition, storage, and identification per MDOT 708.02** **Use non-deformed steel rods in accordance with AASHTO M 270 Grade 36 and hot-dip galvanized in accordance with AASHTO M 111, as position dowels for precast beams** **Bar reinforcement for prestressed concrete beams must meet the requirements of ASTM A 616-96a for Grade 60 steel bars, except the Engineer will allow bar reinforcement that meets the requirements of ASTM A 615 or ASTM A 617-96a for Grade 40 steel bars for stirrups in prestressed concrete beams** **Ship bar reinforcement in standard bundles, tagged and marked in accordance with the CRSI Code of Standard Practice**	General Certification
25	Material Verification – Reinforcing Steel (Bent/Fabricated)	708.02 905.03.A	Applicable ASTM or AASHTO specification Minimum Bend Diameters per Table 905-1 Approved Manufacturer	P			Prior to placement	**Confirm fabricated reinforcing steel quality, condition, storage, and identification per MDOT 708.02** **Bent bar reinforcement must be cold shop bent to the shapes shown on the plans. Complete all field bending cold as specified. Heat bending is cause for rejection.** **The diameter of a bar bend, measured on the inside of the bar, must meet the requirements of Table 905-1.** **Bar cutting and bending must be in accordance with the CRSI Code of Standard Practice and the ACI Detailing Manual.**	General Certification
26	Material Verification – Reinforcing Steel (Epoxy Coating)	708.02 905.03.C	AASHTO M 284 Approved Manufacturer MDOT QPL – epoxy material	P			Prior to placement	**Confirm coating selection of material from QPL and written certification of cleaning, coating and testing to AASHTO M 284** **Damaged coating repaired per MDOT 706.03.E.8**	General Certification
27	Material Verification – Welded Wire Fabric	708.02 905.06	ASTM A 497 Approved Manufacturer	P			Prior to placement	**Confirm welded wire fabric material condition, storage, and identification per MDOT 905.06 and PCI MNL 116-99** **Deformed wire fabric for prestressed concrete must meet the requirements of ASTM A 497**	General Certification
28	Material Verification – Structural Steel	708.02 906	Applicable ASTM and AASHTO specifications MDOT Fabrication Inspection Accepted	P			Prior to use	**Confirm structural steel material condition, storage, and identification per MDOT 906 and PCI MNL 116-99** **Unless provided by the supplier and accepted per MDOT MQAP:** **- Provide MTRs per 906.03. Confirm impact testing per 904.04** **- Confirm material condition, composition, coating, and testing of high strength Steel bolts, nuts, and washers for structural joints per 906.07** **- Confirm material condition, composition and impact testing of pins and link plates per 906.08** **- Confirm material condition, composition, testing, flux, and ferrules of shear developers (studs) per 906.09**	General Certification MDOT Fabrication Inspection Stamp
29	Sole Plates	MDOT 708-03.A.13.e	AASHTO M 111	P			Each delivery	**Verify hot-dip galvanize sole plates in accordance with AASHTO M 111.**	Galvanizer's Certification/Quality Records

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30	Material Verification – Water	708.02 911	Approval of potable water Supplier by State Department of Public Health Table 911-1 chemistry requirements for non-potable water	R			Prior to use	**Confirm water supply for concrete production per MDOT 911 and PCI MNL 116-99.** **Potable water, from Suppliers approved by the State Department of Public Health, is acceptable for use for concrete, mortar, grout, or for curing concrete, without testing. Non-potable water used for concrete, mortar, grout, or for curing concrete, must be tested in accordance with AASHTO T 26 and must meet the requirements of Table 911-1.**	State Department of Public Health certificate (potable water Supplier) Test Report per AASHTO T 26 (non-potable water testing)
	EQUIPMENT & FACILITY								
31	Equipment Condition and Work Areas	MDOT MQAP 4.04.04.B.3	Contract documents	M			Prior to startup	**The QCI inspects the Supplier's equipment and work area to ensure they are adequate and maintained in a condition that yields product conforming to project requirements.**	Verbal
32	Specimen Molds	708.03.A.4.b	ASTM C 470	P			Prior to use	**Confirm specimen mold condition and testing per ASTM C 470 and PCI MNL 116 Section 6.2.3.2** **At least three single-use and reusable molds shall be selected at random from each shipment by the purchaser to ensure that the molds comply with this specification. Failure of any one of the three molds to comply with this specification shall be basis for rejection of the shipment**	QC Record
33	Curing Tank	708.03.A.4.c	DOT approval Water temperature 70°F ±5°F	P			Prior to use	**Confirm condition and operation of curing tank per MDOT 708.03.A.4.c and PCI MNL 116.** **Provide a Department-approved curing assembly, consisting of a water tank equipped with thermostatic controls. Maintain lime-saturated water at 70 °F ±5 °F. Provide a tank sized to contain the required number of 28-day test specimens**	QC Record
34	Compression Testing Machine	708.03.A.4.d	±1% of full scale reading or ± 2% of the maximum expected test load, whichever is less (PCI MNL 116 Section 6.4.3)	P			Prior to use	**Provide a compression testing machine in accordance with ASTM C 39. Submit to the Engineer, a calibration certificate no greater than 12 months old** **Documentation of the calibration and maintenance of the testing machine shall be in accordance with Practice C1077 (ASTM C 39 5.4)**	Calibration Certificate
	FORM LOADING & TENSIONING								
35	Strand Debonding	12SP-708A-01	Approved Shop Drawings Materials not reactive with concrete as approved by the Engineer	P			Prior to tensioning	**Furnishing and installing rigid polymer debonding material around prestressing strands in precast concrete elements at locations and lengths indicated on the plans. Flexible polymer plastic split-sheathing is prohibited.** **Provide rigid monolithic polymer debonding material with an outside diameter of 0.725 inches and a wall thickness of 0.04 inches**	QC Record General Certification
36	Strand Position – Prior to tensioning	MDOT MQAP 4.04.04.C.1	Material size and specification Strands clean and free of defects No kinks, bends, or nicks Pattern (position/spacing) per shop drawings No unapproved vertical position variation Horizontal position changes meet the conditions of MQAP 4.04.04.C.1.a Debonding limits of MQAP 4.04.04.C.1 .b Supports between strands adequate to hold true position	P			While strand still visible Position and pattern verified just after initial load	**Visual inspection of strand condition, position, supports and use of debonding** **Verify material size and specification.**	QC Record
37	Strand Tensioning – Initial Load	MDOT MQAP 4.04.04.C.2	Stressing jack calibration current Initial load less than 5000 lbs.	P			Each strand	**Witness and record initial loading of each strand**	QC Record

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38	Strand Tensioning – Final Load & Net Elongation Check	MDOT MQAP 4.04.04.C.2	-0/+5% of computed elongation	P			Each strand	**Witness and record final loading and net elongation of each strand**	QC Record
39	Placing Reinforcing Steel & Inserts	MDOT 708.03.A.8 MDOT MQAP 4.04.04.D.3	No welding Reinforcing steel tied Epoxy coated wire ties on epoxy coated steel Correct size & material Free of defects Proper position	P			Lower steel prior to strand tensioning Upper steel prior to pour	**Confirm reinforcing steel and inserts placed per project requirements.**	QC Record
40	Placing Void Boxes	MQAP 4.04.04.D.4	Correct dimensions and position per shop drawing Securely clamped after reinforcement placement Slab thickness over voids within limits	P			Pre-pour After strike-off	**Confirm void box dimensions, position, and fastening to the formwork.** **Spot check top slab thickness after casting and immediately after strike-off**	QC Record
41	Forms	708.03.A.4.a MQAP 4.04.04.D.2	Metal forms except bulkheads Form configuration and condition per MDOT 706.3.D All joints smooth and tight Exposed joint intersections chamfered 0.5" and reentrant angles radiused 0.75"	P			Prior to pour	**Confirm form condition and cleanliness per MDOT 706.3.D and PCI MNL 116.** **The Supplier may use wood forms for bulkheads** **The Engineer will approve the sizing, spacing, and dimensions of metal, composition, or special plywood forms (for Type A surfaces), and allow continued use based on performance.**	QC Record
	CONCRETE PRODUCTION & CURING								
42	Fresh Concrete Test (Startup Sampling and Testing)	12SP-708C-01.c.5.D	Slump Density (unit weight) Air content = 5.0 to 8.0% up to 8.5% for Type F or G admixture	P			QC – first load daily QA – first load daily	**Conduct startup sampling and testing for temperature, slump, density (unit weight), and air content on the first load** **The Engineer will verify the Supplier's daily startup sampling and testing of temperature, slump, and air content of fresh PCC on the first load;**	QC Record
43	Correlation Check of QC/QA Test Equipment	12SP-708C-1.d.2	Temperature – within 2 deg F Air content (2 tests) – within 0.8 %	P			First load Each change in QC/QA equipment or personnel As directed by the Engineer	**The testing equipment and associated testing personnel for both the Engineer's QA testing and Supplier's QC testing must be used to conduct side by side correlation testing of the same PCC from the first load to verify correlation of both the Department's and the Supplier's test results for temperature and air content of fresh PCC.**	QAI Record
44	Molding and Curing Compressive Strength Test Cylinders	MDOT 708.03.A.7.a	Cylinders molded and cured per ASTM C31 Fresh concrete sampled per ASTM C172 At least six test cylinders per line	P			1/3 from each of 3 separate batches or loads per casting line	**The Engineer will base acceptability of concrete strength on the results of compressive strength tests on standard 6-inch by 12-inch or 4-inch by 8-inch cylinders.** **Make at least six test cylinders from concrete for each prestressed product line.** **Mold and cure cylinders in accordance with ASTM C31, except as modified by this subsection. Leave cylinders with the product or in the curing enclosure until stripping the member. Then, remove the 28-day cylinders from molds and place in a water curing tank until testing. Leave remaining cylinders with the product until testing.**	QC Record
45	Placing Concrete	MDOT 708.03.A.11 MQAP 4.04.04.D.6	Engineer's written approval of forms, bracing, reinforcing steel, and preparation prior to pour per 706.03.H No visible debris in form prior to placing No visual material segregation or reinforcement displacement No interruption in a pour more than 45 minutes Vibrators visibly affect concrete 18" away Consolidation started within 15 minutes of pour	P			Each pour	**Place concrete in accordance with subsection 706.03.H, and as modified as follows:** **a. The Supplier may use external vibrators.** **b. Protect fresh concrete from rain and cover forms during interruption of casting operations due to rain.** **c. Maintain the concrete temperature from 45 °F to 90 °F, as close to 70 °F as practical, during placement.**	QC Record

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46	Consolidation	MQAP 4.04.04.D.7	No visible segregation Rubber coated vibrator head verified for epoxy coated reinforcing steel	P			During pour	A minimum amount of vibration necessary to thoroughly consolidate the concrete must be used. QAI must verify a rubber coated vibrator head is used when epoxy-coated or other coated reinforcement is used	QC Record
47	Curing Beams	MDOT 708.03.A.11	Minimum 50°F concrete curing temperature maintained prior to stripping Maximum 180°F concrete curing temperature maintained prior to stripping (per PCI MNL 116-99 Section 4.18.2)	M			Periodically during curing	Protect concrete from cold weather (during curing) Cure concrete at temperatures from 70 °F to 160 °F until concrete attains the release strength shown on the shop plans. Maintain the required temperature during the curing period with steam or radiant heat Maintain time-temperature documentation	QC Record
48	Accelerated Curing	MDOT 708.03.A.11	Steam or heat not applied prior to initial set per ASTM C403 No more than 80°F per hour enclosure temperature increase during cure or decrease after cure (max 36°F per hour increase and 50°F per hour cooling rate after cure per PCI MNL 116-99 Section 4.19.1.4) Maximum concrete curing temperature of 195°F (max 180°F per PCI MNL 116-99 Section 4.19.1.5)	P			Start of curing	Apply steam or radiant heat after concrete reaches initial set in accordance with ASTM C 403, without damaging the concrete. Verify location and operation of recording thermometers for steam or radiant heat curing, capable of showing the time-temperature relationship in the curing enclosure from the time of concrete covering, to transfer of prestress. Use at least two recording thermometers per product line, at locations determined by the Engineer, to monitor the concrete and the curing rate. Graph time-temperature documentation and provide a copy to the Engineer for evaluation	QC Record
49	Work Progress Test Specimen – Transfer/Detensioning	MDOT 708.03.A.7.b	Testing per ASTM C39 with modified curing conditions Release Strength as specified	P			Prior to transfer/de-tensioning	Use one set of three test cylinders to determine the time of transfer of prestress from end anchorages to concrete. Test in accordance with ASTM C39, except test specimens in moist condition resulting from required curing conditions. Conduct compressive strength tests in the Engineer's presence.	QC Record
50	Release Strand Tension	MDOT 708.03.A.15	Specified release strength achieved Release sequence minimizes eccentricity	W			Each strand	Do not transfer bond stress to concrete, or release end anchorages until concrete attains the required compressive release strength. Cut or release prestressing strand to minimize lateral eccentricity of prestress. After detensioning strands, cut flush with the concrete surface and cover ends and depressions around cable ends with asphaltic material approved by the Engineer.	QC Record
	INSPECTION								
51	As-cast Dimensions	MQAP 4.04.04.D.1	Dimensions per shop drawings	P			Post-pour	Confirm the dimensional requirements of the bulkheads, side forms, bearing plates, steel reinforcement, void boxes, inserts, and any other devices per the approved shop drawings. Anything that cannot be inspected post-pour, must be inspected during pre-pour.	QC Record
52	Workmanship Inspection – Cracks	MDOT 708-03.A.12	Engineer's evaluation	P			Post-pour Prior to shipping	Visually inspect and identify concrete cracking The Engineer will evaluate cracked concrete for approval.	QC Record
53	Workmanship Inspection – Concrete Defects	MDOT 708-03.A.13.a	No more than 1" holes	P			Immediately after stripping	Patch holes larger than 1" with R-2 Mortar as directed by the Engineer. The Engineer will evaluate concrete with honeycomb areas for approval.	QC Record
54	Workmanship Inspection – Finishing I-Beams	MDOT 708-03.A.13.b	Outer 1" top surface – smooth Remaining top surface – ¼" roughness	P			Post-pour	Smooth finish the outer 1 inch of the top surface of the I-beam. Rough finish remaining I-beam top surfaces to provide a ¼ inch surface texture	QC Record

tem No.	Inspection/Test Item	Referenced Requirement	Acceptance Criteria	Code	QC Suspension Limits	QC Action Limits	Frequency	Description	Output / Record
	Hold Point Codes: H = Mandatory Hold Point, Fabricator must notify Inspector and then Inspector must release the operation before the Fabrication can proceed W = Witness / Inspection Point sampling activity, prior notification by the Supplier (quality document required for Inspector activities of this type) R = Review of Required Documents for adequacy and completeness M = Monitor through routine observation of the Fabricator's Work Activities (See Annex at the bottom of the document for detailed description of "Observation") P = Perform (responsible for actual completion of the step)A = Approve/Accept to release a hold point								
55	Workmanship Inspection - Finishing 1800 Beams	MDOT 708-03.A.13.c	Outer 6" top surface – smooth, cleaned and debonding compound applied Remaining top surface – ¼" roughness	P			Post-pour	Smooth finish the outer 6 inches of 1800 beam top surfaces. Rough finish remaining 1800 beam top surfaces to provide a ¼ inch surface texture. Clean the outer 6 inches of the top surface and apply a de-bonding compound in accordance with the Supplier's recommendations. Use a compound color that contrasts with 1800 beam flanges to show application after curing. Prevent compound from spreading over 1800 beam flanges or toward the center of the beam. Remove compound that exceeds the 6-inch boundary before it cures. Use solvents approved by the de-bonding compound Supplier.	QC Record
56	Finishing Box Beams	MDOT 708-03.A.13.d	Outer 1" of top surface – smooth Remaining top surface – ¼" roughness or as specified; wood float finish when specified	P			Post-pour	Smooth finish the outer 1 inch of the box beam top surface. Rough finish remaining box beam top surfaces to provide a ¼ inch surface texture unless otherwise required. If hot mix asphalt overlay is required, provide a wood float finish on the top surface	QC Record
57	Bearing Surfaces	MDOT 708-03.A.13.f	1/8" over 12" surface flatness	P			Post-pour	Ensure bearing surfaces meet a flatness tolerance of 1/8 inch over 12 inches.	QC Record
58	Dimensional Inspection	MDOT 708-03.A.14	MDOT Table 708-1	P			Post-pour	Verify dimensional tolerances of finished members. The Engineer will evaluate beams that do not conform to the dimensional tolerances specified in Table 708-1	QC Record
59	Concrete Compressive Strength Test – 28-day	MDOT 708.03.A.7.b	Testing per ASTM C39 as modified i. The average of the compressive strength of the three test specimens equals at least the required minimum compressive strength; and ii. At least two of three specimens meet the required minimum compressive strength and the third specimen exhibits at least 60 percent of the required minimum compressive strength.	P			Prior to shipment	Test optional test cylinder sets before the end of the 28-day curing period. Test all three cylinders of an optional set at the same time. The Engineer will accept optional cylinder test results, in place of the 28-day tests, if optional cylinder test results equal or exceed the 28-day strength requirements. If optional cylinder test results do not meet or exceed the 28-day strength requirements, continue curing remaining sets of three test cylinders for the full 28-day period. Test remaining three cylinders at 28 days to determine acceptability of the concrete strength. Do not ship product until it meets 28-day strength requirements. Conduct compressive strength tests in the Engineer's presence.	QC Record
60	Material Verification – Mortar and Grout	MDOT 708.02 MDOT 702	Proportions per Table 702-1A or 1B Properties of components per MDOT specs	P			Prior to mixing	Confirm mortar and grout component material condition, storage, and identification per MDOT 708.02 and PCI MNL 116-99 Provide Mortar and Grout in accordance with MDOT 702 Proportion R-2 mortar for patching air holes and spalls per Table 702-1A or 1B Conformance of mortar components (Type I or IA Portland Cement, Type N, S, or M Masonry Cement, Type S or SA Hydrated Lime, 2NS or 2MS Fine Aggregate, Air Entraining Mixtures, and Water) to MDOT Specifications No mortar or grout placement below 40°F. No retempering after it begins to set (702.03) Visual inspection of standard mortar and grout.	QC Record
61	Fabrication Inspection Acceptance – for shipping	MQAP 4.04.07.B	Contract documents No unresolved NCRs	P			Each load	Structural elements must be inspected by the QAI after they are loaded for shipping. If the structural elements meet the contract requirements, the QAI will stamp them "Approved for Use". The elements must be stamped "Approved for Use" prior to shipping. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for use by the Department and does not relieve the Supplier of their responsibility to meet contract requirements	Stamped Beams Stamped Bills of Lading

SPECIAL NOTES

1. None yet

Appendix A4: Suggested Radiographic Testing Procedure (non-mandatory)

Radiographic testing (RT) inspection of weldments as required by the contract must be performed in accordance with the applicable welding code as modified by the contract. The following procedure is a non-mandatory suggested format that meets the requirements of most MDOT contracts.

1. Fabricator must furnish a satisfactory viewer and darkroom facility for developing and viewing the radiographic film and must also provide shop space and time for all radiographic work. All safety precautions as required must be followed and enforced by the Fabricator.

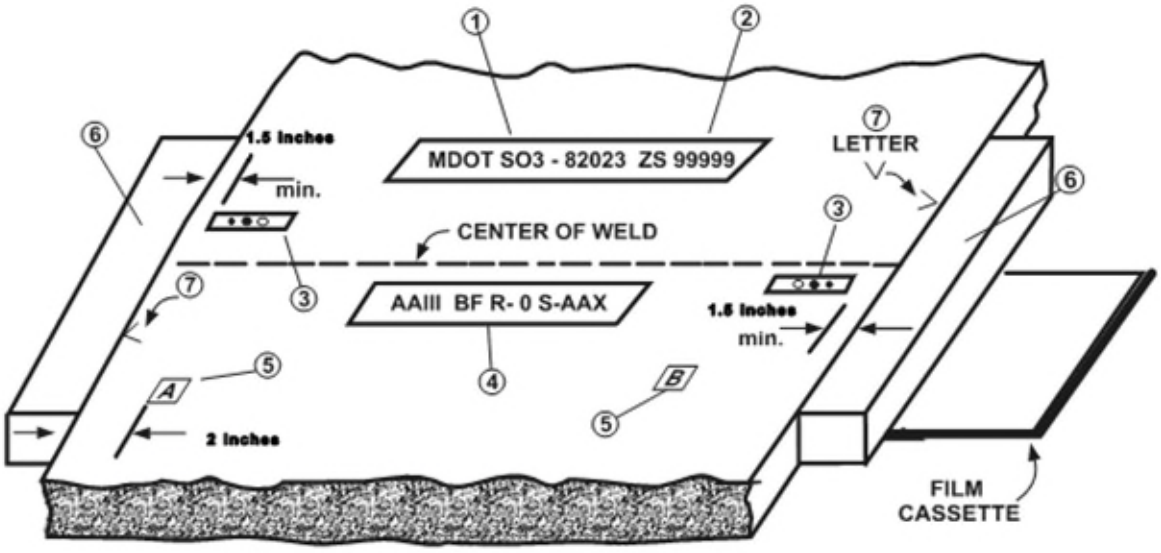
2. See the contract for RT inspection requirements. All joints must be free of dirt, scale, grease, etc. prior to inspection. Flange splices must be ground flush on both sides and webs ground flush at the area to be RT (one side). The direction of grinding must be perpendicular to the length of the weld. All runoff tabs or other appendages must be completely removed before RT inspection.

3. Radiographs must be taken and interpreted by experienced and qualified technicians or radiographers as approved by the Engineer. The radiographic film and a report of the technician's interpretation must be submitted to the Engineer for their final approval before the weld is accepted. The film type must be fine grain Class I or Class II. Dimensions must be a minimum of 4.5 inches by 17 inches. Areas too large to be RT inspected on one film will require additional exposures. Limit web shot film size to 15 inches and flange shot film size to 16 inches. Either x-rays or gamma rays may be used to produce radiographs. Double lead screens must be used to back the film. Screens may be either pure lead or antimony lead with a maximum of 6 percent antimony. Tin coated lead foil or fluorescent screens must not be used. If RT inspection discloses defective welds, the defective portions must be removed and the material re-welded. Additional films must be taken of all repaired welds at the expense of the Fabricator and then submitted to the Engineer for approval.

4. The interpretation of all radiographic films must be furnished to the Engineer by the Fabricator. The interpretation report must be submitted on a form as approved by the Engineer. Should the Engineer question the interpretation of the radiographic film by the technician, or should the Fabricator question the interpretation of the Engineer, a joint review will be made. The Engineer's final interpretation will govern.

5. All radiographs must be positively identified by the Fabricator in accordance with AWS D1.5. Identification lettering of radiographs must be placed on the source side along with the penetrameters. Lettering of repairs must show an "R" and the number of the repair and must

be placed next to the weld identification.



Standard Radiographic Identification Layout - (numbers refer to diagram above)

Explanation

① State structure number and control section.

② Fabricator's initials and shop contract number.

③ Penetrameters. Use penetrameters for nominal thickness of each plate, but penetrameter for thicker plate not to exceed penetrameter for thinner plate by more than ten.

④ Weld Identification. Identification should identify the exact location of the weld in relation to piece number and location.

⑤ Location Letters. Placement of location letters is necessary to relate the location of questionable areas or defects should repair be necessary. More location letters must be added in the event more than one shot is required.

⑥ Tight fitting steel edge blocks must have a thickness equal to or greater than the thickness of the weld on all weld ends.

⑦ Lead “V” must be placed at edge to delineate the top edge on the radiograph. Additional identification may be used as required. All lead numbers and penetrameters must be placed on the source side of the plate being radiographed.

The use of "blocks" as illustrated is required. The use of these edge blocks will give a better picture of the top and bottom edges and are especially useful when the limits of the film are being crowded (e.g., one shot on a 16-inch flange).

Reserved for future inclusions.