Improved Regionalization of Quality Assurance (QA) Functions

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This study conducted an in-depth review of the current quality assurance (QA) processes for precast (PCE) and prestressed concrete elements (PSE) used in the highway construction in the New England region. On basis of the review of current practices and through input from the six New England State Transportation Agencies (STA) a set of unified QA process recommendations have been developed. Adoption of unified QA processes will enable STAs to be able to cross-utilize inspection resources and allow producers to follow same quality control; (QC) guidelines. Both of these are expected to realize cost savings for STAs. This will result in a significant save in the financial resources by reducing the number of QA inspectors while the manufacturers for different construction projects around the region follow a unified procedure for maintaining and evaluating the quality of their products. Recommendations for plant/producer pre-qualification, pre-pour, during pour and post-pour QC and agency inspection practices have been developed and are provided in this report.</td></tr>
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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List of Acronyms

- AASHTO – American Association of State Highway and Transportation Officials
- AMRL – AASHTO Materials Reference Laboratory
- CFR – Code of Federal Regulations
- CIP – Cast in Place
- COCs – Certificate of Compliance
- CY – Cubic Yard
- DOT – Department of Transportation
- FHWA – Federal Highway Administration
- HMA – Hot Mix Asphalt
- IA – Independent Assurance
- IRFs – Inspection Report Forms
- MSM – Material Sampling Manual
- NHS – National Highway System
- NPCA – National Precast Concrete Association
- PCC – Portland Cement Concrete
- PCE – Precast Elements
- PSE – Prestressed Elements
- PSF – Pounds per Square Foot
- psi – Pounds per Square Inch
- QA – Quality Assurance
- QAI – Quality Assurance Inspector
- QAP – Quality Assurance Program
- QC – Quality Control
- QCP – Quality Control Plan
- QSM – Quality Service Manual
- SHS – State Highway System
- TRFs – Testing Report Forms

1. Introduction

The current phase-I final report for the NETC 13-3 study intends to establish a uniform policy of quality assurance (QA) inspection procedure for the three different types of precast concrete elements that include pre-stressed concrete elements (PSE) as well as structural and non-structural concrete elements (PCE) that are used in the construction of bridges in the New England region. This policy is based on the findings from the review of the QA processes presented in this report. The main objective of this study is to reassure that the manufactured products have the required standards while all the state DOTs follow the same procedure in determining the quality of the fabricated elements. This will result in a significant save in the financial resources by reducing the number of QA inspectors while the manufacturers for different construction projects around the region follow a unified procedure for maintaining and evaluating the quality of their products.

The report is organized into six primary chapters. This chapter presents the overview and motivation for the research study along with standard definitions applicable to QA processes. Chapter 2 discusses the findings from literature review on the topic. Chapter 3 reports on the major activity of NETC 13-3, task-1 which is review of QA processes for NETC constituents through specification and manual evaluations as well as interview of agency personnel. The input from interview of two PSE/PCE fabricators are also included in the review. Chapter 4 introduces the plant certification and producer testing requirements for PSE and PCE and introduces the suggested changes to these requirements. Chapter 5 discusses the current agency QA inspection requirements and introduces the suggested changes to these practices Chapter 6 summarizes the findings from the review and presents a summary of suggestions for a unified QA process that might be adopted by New England states as well as the conclusions from this study.

1.1 Motivation for this Study

The use of quality assurance (QA) systems in highway infrastructure is critical to ensure durable, safe, and economical transportation operations. These processes ensure that the desired level of quality is maintained throughout the manufacturing processes. Adherence to the Code of Federal Regulations Title 23, part 637 “Quality Assurance Procedures for Construction” (Federal Highway Administration, 2011) is required for all Federal-aid highway projects by the State Departments of Transportations (DOTs). The Transportation Research Board Circular on Glossary of Highway Quality Assurance Terms (Transportation Research Board, 2009) described that QA process as:

> All those planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service. [QA addresses the overall problem of obtaining the quality of a service, product, or facility in the most efficient,

economical, and satisfactory manner possible. Within this broad context, QA involves continued evaluation of the activities of planning, design, development of plans and specifications, advertising and awarding of contracts, construction, maintenance and the interactions of these activities.]

The main activities required by the agencies following QA includes the acceptance program as well as the independence assurance program. The development of an independent assurance program is required at the initiation of the QA process implementation as well as periodically to ensure that qualified personnel are available. The acceptance process requires continuous resources on the part of DOTs in the form of inspectors and process evaluators as well as costs associated with verification testing. The cost associated with the required manpower can accumulate quickly. For regions such as New England, a significant cost savings can be realized if the QA resources are shared amongst the agencies. This is especially true for the components of highway construction where: (1) limited variability is present between state specifications; (2) the quantity of work is not large enough to warrant a large number of inspectors within each agency and their district offices; (3) several contractors provide materials and construction for multiple agencies. The precast/prestressed concrete elements (PCE/PSE) used in highway construction is one such component. In order to pool the resources and realize cost savings, it is necessary for the agencies to have a unified QA process driven by use of common acceptance standards. Furthermore, a cost-sharing program is necessary when the QA related activities are performed by one agency on behalf of another agency so that the costs can be recovered and charged to the correct project. The phase-II of this study is focused on the cost share aspect and will make recommendations regarding that aspect. The purpose of this phase-I study is to develop common acceptance standards for the PCE/PSE for New England State Transportation

1.2 Definition of QA Terms

The following terms are listed and defined to aid in the understanding of the language used throughout this report.

Acceptance Program

A thorough and consistent evaluation of all factors that are to be used by the Owner to determine the quality and acceptability of the product or work as specified in the contract requirements. These factors include, but are not necessarily limited to, *material certifications*, *acceptance sampling and testing* and inspection.

Acceptance Sampling and Testing

Sampling, testing, and the assessment of test results to determine the quality of produced material or construction is acceptable, in terms of the specifications.

Agency Laboratory

An Agency owned laboratory other than the c*entral laboratory* where *acceptance* samples are processed by Agency personnel or representatives.

Accredited Laboratory

It is a laboratory that is accredited by the AASHTO Material Reference Laboratory (AMRL).

Consultant Laboratory

An Independent Laboratory in which independent and *qualified personnel* process *acceptance* samples.

Central Laboratory

The Agency's primary laboratory.

Certified Personnel

Any person determined qualified by an appropriate certification program, as determined by the Owner.

Clarification and Resolution of Material Test Results

The procedure used to resolve disagreements between the Owner and its *Contractor* regarding material quality and material test results.

Confirmation

The act of determining whether the product supplied matches the product identified in the material certification submitted.

Contractor

The individual, partnership, firm, corporation, any acceptable combination thereof, or a joint venture which is a party to the Contract with the Owner which is undertaking the performance of the work under the terms of the Contract and acting directly or through its agent(s) or employee(s). The term "*Contractor*" means the prime *Contractor* as differentiated from a *Subcontractor*.

Contractor Laboratory

A laboratory which may be owned and/or operated by a *Producer or Contractor*. This laboratory may be located on a construction site for the purpose of processing *Acceptance* or *quality control* samples.

Fabricator or Producer

A company that produces or fabricates materials for use on a specific project (i.e. Aggregate, Hot Mix Asphalt (HMA), Portland Cement Concrete (PCC), Precast/Prestressed Concrete) by either the *Contractor* or *Subcontractor*.

Independent Assurance (IA) Comparison

The act of evaluating the variation between the Acceptance and IA test results. The results of a comparison are documented in an IA Comparison Report.

Independent Assurance (IA) Sampling and Testing

Sampling and testing that is conducted by the Certifications and Independent Assurance (C&IA) Unit of the Materials & Research Section to provide an unbiased and independent evaluation of the Acceptance Program.

Independent Assurance (IA) Program

Unbiased activities that are performed by *certified personnel* that are not directly responsible for *quality control* or *acceptance*. These activities provide for an independent assessment of equipment, and evaluation of the sampling and testing methods employed during the *Acceptance Program* to ensure conformance with established procedures. Test procedures used in the *Acceptance Program* performed at the c*entral laboratory* are exempt from this program. Test results of IA tests are not to be used as basis of material *acceptance*.

Lot

A defined quantity of material from a single source assumed to be produced and/or placed essentially by the same controlled process.

Manufacturer

A company that manufactures and supplies *standard manufactured materials* or fabricated materials for use on a project.

Material Certifications

Documents submitted pursuant to Subsection 700.02 of the Agency's "Standard Specifications for Construction" by the *Manufacturer* or *Producer* of a product that assures (or certifies) that the product used in the work conforms to all applicable requirements of the Owner's standard specifications, drawings, and contract provisions for the intended project.

National Highway System

The *National Highway System* (NHS) includes the Interstate Highway System as well as other roads important to the nation's economy, defense, and mobility. The NHS was developed by the United States Department of Transportation (USDOT) in cooperation with the states, local officials, and metropolitan planning organizations (MPOs).

Non-Structural Concrete Elements

Non-structural concrete is concrete that has a low strength and will be used when only small compression or temporary loading is involved.

Population

All of the specimens obtained from a *lot* that are used to represent the entire *lot* of material.

Qualified Laboratory

A non-accredited, Owner approved laboratory that provides test results used to determine acceptance.

Qualified Personnel

Personnel that have successfully completed the Agency's Qualified Technician Program or an Owner approved qualified technician program.

Quality Assurance Program

Documented, predicted, and systematic actions conducted to provide sufficient confidence that a product or service will satisfy given or specified requirements.

For example, it identifies the various elements of the Owner's sampling, testing and inspection programs that are in place to assure that the materials and workmanship incorporated into the Owner's construction projects are in conformity with the requirements of the approved plans and specifications including approved changes.

Quality Characteristics

The specific material properties evaluated by *quality control* and *acceptance sampling and testing.*

Quality Control

All activities performed by the *Contractor*, *Producer*, and *Manufacturer* in the manufacturing, production, transport and placement to ensure the materials incorporated and work performed on a project meet or exceed contract specification requirements. These activities include material handling, construction/manufacturing procedures, calibration and maintenance of equipment, production process control, sampling and testing, and inspection that are accomplished to complete the work involved in an Owner project.

Quality Control Plan

A detailed document prepared by the *Contractor* or *Producer* identifying the processes to ensure the quality of material.

Referee Sample

A split or replicate sample that is taken, prepared and stored in an agreed upon manner for the purpose of settling a dispute.

Replicate Samples

Two or more material samples taken at the same location and time. These samples are taken to estimate sampling and testing variability.

Split Sample

A split sample is a single material sample that has been divided into two or more portions. These samples are taken to estimate testing variability.

Standard Manufactured Materials

These are items produced routinely (i.e. not for a specific project) by a *Manufacturer*.

Structural Concrete Element

A structural element is a member or part of a building, e.g. a beam, column, wall or floor slab, designed to carry loads of various kinds imposed upon it. The element is usually subjected to bending or direct forces or a combination of these.

Subcontractor

An individual or legal entity to whom or which the *Contractor* sublets part of the work.

Validation

The process of comparing two independently obtained sets of test results to determine whether they came from the same *population*.

2. Background

This chapter describes review of literature on the topic of QA processes for PCE/PSE. The chapter also describes the questionnaire and the interview process used in this study for gathering of the information.

2.1 Literature Review of QA Processes

2.1.1 Quality Assurance Process for Highway Construction

As described previously, the federal code of regulation (23 CFR 637) requires all State DOTs to adhere to the QA procedures set forth by FHWA for all construction activities conducted through the federal aid. Furthermore, FHWA recommends that the DOTs use the same QA procedures for all other non-federal aid work.

Under the federal requirements, each DOT is required to develop and implement a QA program to ensure that the materials and workmanship in highway construction projects conform to the approved plans and specifications. Such a QA program requires the DOTs to maintain qualified staff and a central laboratory to administer the program. The QA program consists of three major components: (1) Acceptance Program; (2) Independent Assurance; and, (3) Preparation of Materials Certification.

The Acceptance Program consists of the information regarding the frequency guide for verification sampling and testing, identification of locations where verification sampling and testing should be accomplished as well as specific attributes that should be inspected. All of these aspects are specific to the type of construction activity. Quality control (QC) test results from the contractors can be used as a part of the acceptance program as long as qualified laboratories and personnel are used, verification samples have been tested to validate the results from the QC testing, and the sampling and testing procedures have been evaluated through an Independent Assurance (IA) program. As part of the acceptance program, the DOTs are also required to have a dispute resolution process for instances where the discrepancy exists between the verification and QC sampling and testing results.

The IA system is required in order to ensure uniformity in the sampling and testing procedures and to be able to use QC samples and test results for the acceptance program. The IA program evaluates the sampling and testing personnel and procedures and testing equipment to certify the quality of the process. As part of the IA program the DOTs are also required to provide a schedule of frequency at which the IA evaluation should be conducted. Thus, an extensive QA program is required for each component associated with highway construction, which can lead to high cost associated with number of employees and testing facilities. An estimated manpower requirement for DOT to maintain an IA system is estimated to range between 0.5 to 16 full-time equivalent staff members per 100 million dollars (2005 dollar value) of construction and maintenance budget (Hughes, 2005). Quality Assurance (QA) specifications can be used to meet the requirements of 23 CFR 637. These specifications require the contractor to be fully responsible for controlling the quality of work, and the agency to be responsible that the quality achieved is adequate to meet the specification bid (Benson, 1999). This safeguards the State Department of Transportations (DOTs) against inferior products and lowers the risk on part of agencies.

Common Acceptance Standards

Regional partnerships between DOTs can significantly lower the economic burden on agencies through use of common acceptance standards for QA. The National Cooperative Highway Research Program (NCHRP) synthesis of the DOT management techniques for QA reported a number of multi-agency agreements (Smith, 1998). These included agreements between Arkansas, Oklahoma, and Texas DOTs for conducting inspection of coating processes used in epoxy coated rebar and use of common paint specifications by New England States. The same study indicated that 35 DOTs participate in some form of user-producer groups to address quality problems. Similarly, the combined state binder group (Iowa, Minnesota, Nebraska, North Dakota, South Dakota and Wisconsin) have developed common certification method for acceptance of asphalt binders.

In order to pool the resources and to benefit from common acceptance standards, there is a need to develop such standards. While a number of common acceptance standards exist for services and materials used by DOTs, a review of literature showed that at present no common acceptance standards exist for PCE/PSE. Development of common acceptance standards for PCE/PSE to be utilized by New England states will lead to significant cost savings by the NETC member states. The development of such common acceptance standards will require an accompanying cost sharing method so that the costs associated with inspection and testing can be efficiently and fairly shared by agencies.

2.1.2 Overview of QA Practices for Precast/Prestressed Concrete Elements

AASHTO R 38 Specifications

The AASHTO R 38 specifications provide the minimum criteria and guidelines for establishing and implementing QA procedures for standard manufactured materials used in highway construction (AASHTO, 2012). The standard manufactured materials can be categorized as: project-produced materials; fabricated structural materials; and, standard manufactured materials. While the PCE/PSE components fall under the fabricated structural materials category it should be noted that the constituent materials used to manufacture PCE/PSE such as, Portland cement concrete (PCC), fall under the standard manufactured materials category.

Following the minimum QA requirements put forth through AASHTO R 38 specifications, the agency acceptance of the standard materials require three primary activities. Brief descriptions of these are provided below:

(1) *Approval of the contractor Quality System Manual (QSM)*: Quality System Manual is a comprehensive document put together by the contractor that provides complete information regarding the contractor's QC practices. This includes: quality statement, contact information, QC staff and their qualifications, laboratory equipment and procedures, equipment calibration procedures and frequency, manufacturing inspection procedures and frequency, details on testing of constituent materials, QC sampling and testing methods and applicable specifications etc. The agency is required to review the QSM and if it meets the QC requirements put forth by the agency then the agency will approve it. Typically approval is valid as long as the contractor adheres to the QC procedures described in the QSM. New review and approval is required when or if any changes occur to the QSM.

(2) *Acceptance Inspection, Sampling, and Testing*: The specific procedures for acceptance vary with the materials and services as well as the agency practices. As per the AASHTO guidelines, the agency will not typically conduct inspection and testing during the manufacturing process. Out of the delivered lot the agency will conduct some verification testing to check against the contractor's QC results. While the frequency of testing varies, typically between 10%-20% of the contractor QC frequency is recommended as acceptance verification frequency. The qualified inspectors form the agency conduct the acceptance inspection of the manufacturing and construction processes. As part of the acceptance standards the agencies are required to have clear descriptions of the specification limits and the consequences associated with these limits. The consequences could include the pay factor adjustments as well as the process for resolving the discrepancy between the contractor's QC results and verification testing results.

(3) *Acceptance Documentation*: The agencies are responsible for designing the necessary acceptance documentation. The necessary certificates of compliance (COCs) are often times provided as blank forms or templates that contractors fill out during the QC process. The agency should conduct a review of COCs and have necessary forms and certificates to document the inspection, sampling, and testing information. Typically, standard inspection report forms (IRFs) and testing report forms (TRFs) are developed by agencies and are used by all agency inspectors.

Industry Standards for QC Requirements (PCI and NPCA)

The Precast/Prestressed Concrete Institute (PCI) has developed a comprehensive QC manual for plants and production of PCE/PSE (Precast/Prestressed Concrete Institute, 1999). The manual is prepared to aid manufacturers and contractors in developing QC processes; the document is also commonly referred to as MNL-116. One of the objectives of the study is to develop common acceptance standards for PCE/PSE to be used by the New England DOTs. While the PCI manual was not developed for this purpose, it does provide insight into key inspection and testing criteria that should be part of the acceptance specifications. As per the PCI recommendations, the acceptance inspection should entail evaluation of records on: testing of materials, tensioning of prestressed steel, concrete proportioning, placement and curing of concrete, inspection of finished products, camber, dimensions of the element, and concrete strength. The PCI manual provides an in-depth description of the recommended testing program. The testing of materials used in manufacture of concrete (cement, aggregates, admixture, and water) is often times not necessary by the contractors as the manufacturer have their own QC programs and provide the certificate of compliance. Similarly, the QC testing of prestressing and reinforcing steel is also often times not required as long as the manufacturing mill supplies the QC results and certifies the product to a nationally accepted specification (such as, ACI 318). As part of the acceptance specifications, the agencies will provide the minimum testing frequencies for the compliance testing; for example, sieve analysis and unit weight tests on fine aggregates is recommend once for every 500 tons of fine aggregates and 1000 tons for coarse aggregates. The concrete mix design (proportions) is required to be submitted for each batch along with test results and verification samples. As per PCI the concrete QC evaluation should include air content, durability, and strength requirements. The recommended tests include: concrete compressive strength test, slump test, unit weight measurement, and air content measurements. As part of the production testing, the concrete samples should be cured in similar fashion as the PCE/PSE components themselves in order to have representative curing conditions. The National Precast Association (NPCA) has developed a QC manual for the plants manufacturing PCE/PSE (National Precast Concrete Association, 2015). The manual follows roughly similar recommendations as provided by the PCI manual however it is focused more towards the plant operations and the training and qualification of QC personnel. The NPCA also offers a plant certification program that can be used by the contractors. The QC procedures and requirements of both PCI and NPCA are discussed later in report (Chapter 3)

Cost-share Mechanisms for Unified Specifications and Acceptance Processes

For the instances where common acceptance standards are used by multiple DOTs, a well-defined cost share mechanism is necessary to determine how the costs can be fairly shared and recovered from appropriate projects. An example of such a cost structure exists between State DOTs and corresponding local agencies within the state (Cities, Counties, Townships etc.). Often times smaller transportation entities utilize the State DOT labs and personnel for purposes of acceptance testing. State laboratories (central lab and district labs) typically have standard rates assigned for conducting various tests and a similar structure can be developed in parallel with the common acceptance standards.

Secondly a number of transportation agencies utilize consultant contracts for purposes of QA inspections. The cost associated with consultant contracts are available and can form baseline for establishing standard rates for inspections.

2.1.3 Summary of Literature Review

The background information collected through the review of literature can be summarized by the following key points.

- The Code of Federal Regulation (23 CFR 637) requirements govern the QA requirements for State DOTs.
- A number of common acceptance methods have been developed and used for various materials and services in various regions by a number of State DOTs. Use of such common acceptance standards can lead to significant cost savings and greater efficiencies. At present, no agencies in United States have shared common acceptance standards for prestressed and precast concrete elements used in highway construction. The development of common acceptance standards for PCE/PSE to be used by New England DOTs is a feasible option and can help lower the QA costs for the agencies.
- The common acceptance standards for PCE/PSE can be developed because current standards used by New England DOTs are similar in several aspects. For example, all prestressed concrete fabrication facilities are required to be PCI certified and following PCL MNL-116 requirements for quality control.
- The sharing of inspection and testing costs among the agencies is an important aspect associated with development of common acceptance standards.

2.2 Review Methodology

On basis of the project proposal, feedback from the technical committee and through review of literature, a methodology for collecting information from New England DOTs was established for this study. The process is briefly discussed here.

2.2.1 Information Gathering

The review of the practice began with an in-depth review of PCE/PSE acceptance specifications of all NETC constituents. The most recent standards as well as quality assurance manuals and plans were requested from all states agencies. This was immediately followed by interviews with staff from each of the six DOTs. The research team developed a questionnaire to be used throughout the interview process to aid in the collection of pertinent information. The questionnaire was developed using the information gathered throughout the literature review. The relevant questions to this study that remained after the completion of the review of each state's practices were the first to be added into the questionnaire to provide further insight into the processes. Additional questions were added by reviewing similar projects and the questionnaire those particular studies produced. After the draft of the questionnaire was completed, the team held a kickoff meeting to provide an update on the project to the constituents as well as taking the time to get preliminary feedback on the questionnaire.

The kickoff meeting allowed the constituents to contribute to the questionnaire and edit the questions to provide information that they would like to see added or removed from their current specifications. This meeting led to the finalization of the questionnaire that was used in the interview of all six New England transportation agency personnel from research and materials offices. The document was used as a guide for conducting the interviews to maintain the consistency of the information gathered from each agency. The questionnaire used during the interview is attached as appendix to this report (APPENDIX-A)

Through the interview process, the team was able to gain first hand insight into the inspection processes for each agency. The information gained included a further review of the specifications currently in use, whether the agency uses consultant inspectors or their own employees, and if the inspector performs their own testing or if they observe the quality control technician perform the required testing. The agencies were asked to provide checklists of the inspection processes that proved to be helpful in developing the comparison tables amongst the agencies.

2.2.2 Information Processing

The information gathered throughout the process was compiled into a single master table that tabulated the specifications of interest for each agency. The document incorporated information obtained through the literature review, the interview process, and the documents obtained from the interviews as well as the various agency websites. Next chapter presents summary of the review findings along with discussions on pertinent aspects as they relate to development of unified QA processes for New England states.

3. Review of State Practices

3.1 Introduction

This chapter presents a summary of the QA process review undertaken as task-1 of the study. As discussed earlier in this report, the review was conducted through evaluation of the specifications and manuals as well as interviews with agency personnel. The interviews were transcribed and are attached as appendix to this report (APPENDIX-B). The review results were realized in form of a master table that compares various attributes of QA processes between the six New England states. For purposes of presenting the results of review, sub-sets of information from the master table are extracted presented here along with pertinent discussions. These include list of fabricators that have recently fabricated PSE and PCE to New England DOTs, plant qualification processes, QC technician certification requirements, inspection processes (including inspector qualification, attributes inspected, reporting requirements etc.), cost of inspection, and the curing requirements. The master table is attached with the report as appendix (APPENDIX-C). A sample of specification items from each state that fall into the categories of PSE, Structural PCE, and Non-Structural PCE are detailed in Table 1 below.

Table 1 – Sample Specification Numbers by Element Category

Agency	Prestressed Elements (PSE)	Structural Precast Elements (Structural PCE)	Non-Structural Precast Elements (Non-structural PCE)
CT	5.14	5.07	5.07
MA	M4.03.00	M4.02.14	M4.02.14
ME	535	534, 712.061, 674, 681	603, 604
NH	520, 528, 574	510, 594	603, 604, 606, 614, 625
RI	804, 809	805 (precast modular wall)	701, 702, 704, 705
VT	510	540	540

3.2 List of Fabricators Currently (recently) Supplying PSE/PCE to New England DOTs

This section provides details on the approved fabricators that are supplying PCE or PSE to the New England states as well as lists PCI and NPCA certified facilities in the region.

3.2.1 Approved Fabricators

The following section details the approved fabricators of both PSE and PCE for each state agency. The lists were developed using information obtained from the interviews as well as documents provided by the websites of each agency.

Connecticut Department of Transportation

Arrow Concrete Products (CT), Atlantic Pipe (CT), Oldcastle (MA, CT), Concrete Systems Inc. (NH), Connecticut Precast Corp. (CT), Cromwell Concrete Products, Inc (CT), Rinker Materials (CT, MA), W.E. Dailey (VT), Durastone Corp. (RI), Fiore Concrete Products (RI), Fort Miller (NY), LHV Precast (NY), Rex Precast Systems (CT), Unified Concrete Products, Inc. (CT).

Massachusetts Department of Transportation

Armtec Ltd (CAN), Arrow Concrete Products (CT), Blakeslee Prestress Inc. (CT), CSI (NH), CSI Pipe, LLC (CT), Fort Miller (NY), J.P. Carrara & Sons (VT), LHV Precast (NY), MBO (MA), Michie Corp. (NH), Oldcastle (CT, MA), Rinker (MA), Sabbow & Co. (NH), Scituate Concrete Pipe (MA), Scituate Concrete Products (MA), Shea Concrete Products (MA), Unistress Corporation (MA), Unified Concrete Products (CT), W.E. Dailey (VT).

Maine Department of Transportation

List of qualified fabricators is not published. For PSE total of 6 qualified fabricators (1 in Maine and 6 outside of Maine), for PCE 5 fabricators are qualified, 5 located in Maine, 1 in Massachusetts and 1 in Canada.

New Hampshire Department of Transportation

List of qualified fabricators is not published. At present five fabricators are supplying.

Rhode Island Department of Transportation

Blakeslee Prestress, Inc. (CT), Concrete Systems, Inc. (NH), Durastone Corporation (RI), Hanson Pipe and Precast (CT), J.P. Carrara & Sons (VT), Oldcastle Precast, Inc. (MA), United Concrete Products, Inc. (CT). Majority of PSE are manufactured by Oldcastle Precast, Inc. and Northeast Precast and PCE by Concrete Systems, Inc.

Vermont Agency of Transportation:

List of qualified fabricators is not published. Majority of PSE are fabricated by J.P. Carrara and Sons, PCE are mostly fabricated by W.E. Dailey and Concrete Systems, Inc.

Between the three agencies for which the list of qualified fabricators are commonly published, eight producers are approved to supply to more than one DOT. This shows that fabricators supply to multiple DOTs and use of common acceptance standards can benefit streamlining and lowering costs associated with QA inspections.

3.2.2 Prestressed Fabricators

The PCI certified plants in the New England Area are presented in Table 2. In this table, the PCI certified plants are listed in the rows of the table with the state agencies listed in the columns of the table. An “X” denotes whether the plant has recently supplied PSE to the agency.

Table 2 – PCI Certified Fabricators in New England Region (Mark indicate fabricator supplied PSE to corresponding DOT)

Fabricator (Location)	CT	MA	ME	NH	RI	VT
Blakeslee Prestress Inc. (CT)		X			X	
J.P. Cararra & Sons (VT)		X			X	X
Oldcastle (CT, MA)	X	X		X	X	
W.E Dailey (VT)	X	X				X
Unistress (MA)		X				
Unified Concrete Products (CT)	X	X			X	
CSE (VT)						X
Newstress (NH)						
Strescon Limited (MA)			X			
Coreslab Structures (CT)						
Fort Miller Co. (NY)						
Northeast (PA)					X	
Vynorious Prestress Inc. (MA)						

The list of prestressed concrete fabricators show that several producers have recently supplied PSE to a number of agencies, for example Oldcastle has supplied to four and J.P. Carrara and Sons, W.E. Dailey and Unified Concrete Products each have supplied to three DOTs. This shows that use of common acceptance standards can aid in lowering costs associated with QA inspections as fewer shared inspectors can conduct inspections are some of these facilities on behalf of multiple DOTs.

3.2.3 Precast Fabricators

In this section, Table 3 details the NPCA Certified producers in each New England state. As both the number of precast producers increase along with the quantity of elements, it is not known which fabricators have recently supplied or are currently supplying these elements to the various agencies. In addition, the precast suppliers are subject to change on an annual basis. Comparison of NPCA certified facilities and list of fabricators approved by DOTs indicate that the lists overlap substantially.

Of the 15 NPCA certified fabricators, 11 are on list of approved manufacturers for three of the New England DOTs.

Table 3 - NPCA Certified Fabricators in New England States

Location	NPCA Certified Fabricators
CT	- Arrow Concrete Products Inc. - CSI Pipe LLC - United Concrete Products Inc.
MA	- MBO Precast Inc. - Rinker Materials - Scituate Concrete Pipe Corp. - Scituate Concrete Products Corp. - Shea Concrete Products (Amesbury and Wilmington)
ME	- George R. Roberts Co.
NH	- Concrete Systems Inc. - Michie Corp. - Phoenix Precast Products
RI	- Durastone Corp.
VT	- Camp Precast Concrete Products Inc. - S.D. Ireland Concrete Construction Corporation

3.3 Qualification and Certification of Plant/Fabricator

This section details the qualification of the plants depending on whether they are supplying PSE or PCE. The review of specifications also found differences in the inspector office or facilities requirements between states, thus the differences are briefly summarized later in this section. Table 4 shows the similarities and differences of the required qualification for the plants to fabricate elements for each state.

The plant qualification for prestressed elements is quite similar amongst most states except for the Connecticut DOT and Massachusetts DOT. The Connecticut DOT requires an in-house annual inspection of the plant to certify the plant under their own developed standards. The plant audit checklist is included in APPENDIX-D. The Massachusetts DOT relies on PCI certification but also performs an in-house audit of the plant. The other four states primarily rely on PCI certification.

Plant qualification for PCE varies throughout the six states. Connecticut, New Hampshire, and Rhode Island do not have a specification requiring plant certification for PCE. Although the states do not have a requirement, majority of them indicated in interview that facilities used by them are NPCA certified. Massachusetts and Vermont both allow NPCA certification for the fabrication of PCE. The Maine DOT requires PCI certification for all structural precast items, for other precast items a review is conducted at least once every five years to make sure that AASHTO M157 requirements are met. AASHTO M157 is standard specification of ready-mix concrete.

Table 4 - Qualification and Certification of Plant/Fabricator

Agency	PSE	PCE
CT	CT DOT Prequalification Process	-
MA	PCI Certification followed by MassDOT audit	NPCA or PCI Certification followed by MassDOT audit
ME	PCI Certification	PCI Certification for structural precast, requirements from AASHTO M157 for rest
NH	PCI Certification	-
RI	PCI Certification + RIDOT audit	RI DOT audit
VT	PCI Certification followed by VTAOT audit	PCI or NPCA Certification followed by VTAOT audit

Figure 1, Figure 2 shown below display the plant qualification requirements by state agency for both PSE and PCE respectively.

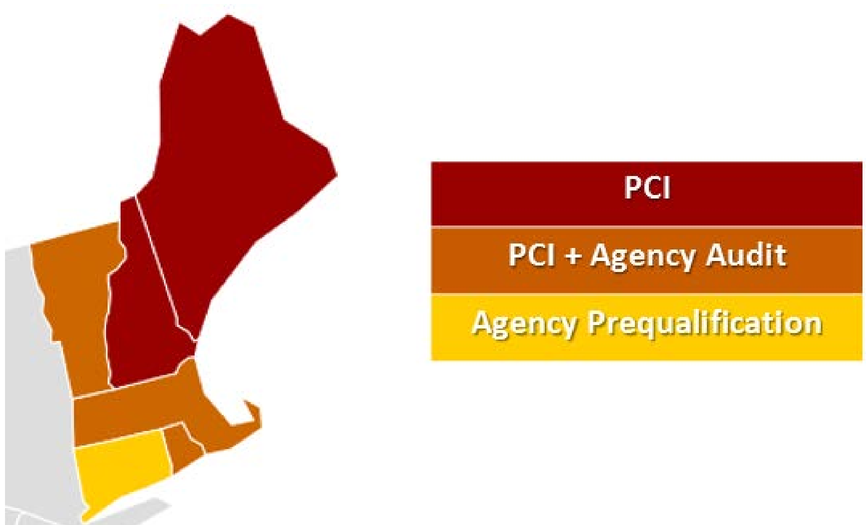

Figure 1 – Qualification of PS Plants

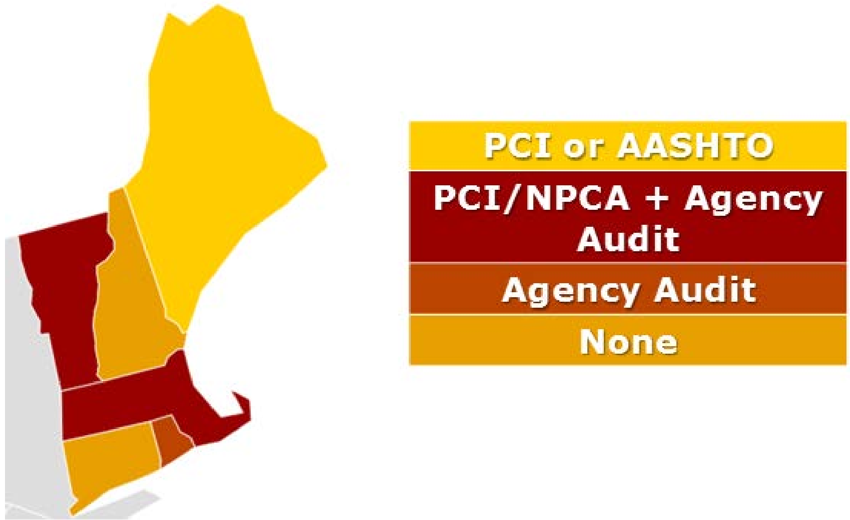

Figure 2 - Qualification of PC Plants

Inspector Office/Facilities Requirements

The office requirements for each state ranged from strict guidelines to not having a specification at all. The Rhode Island DOT has a comprehensive specification detailing the requirements of the office. On the contrary, the Connecticut DOT does not have any requirements regarding office space at the plant or fabricator. Table 5 compares the office requirements of the Rhode Island DOT and the Maine DOT. The remaining states have similar specifications. Examples of the office requirement checklists can be found in APPENDIX-E.

Table 5 - Inspector Office Requirements

Requirement Criteria	Rhode Island	Maine
Minimum Dimensions	200 S.F. with 7.5’ Ceilings	100 S.F.
Doors	2 Doors with adequate locks	No Requirement
Climate Control	Heating and Air Conditioning capable of maintaining year round temperature between 68˚F – 78˚F	Climate Control capabilities of maintaining temperature of 68˚F – 75˚F
Restroom	Toilet, sink, slop sink, vent fan, and running hot and cold water. Toilet paper holders, paper towel dispensers, and soap dispensers.	No Requirement
Telephone	Telephone handset and answering machine.	No Requirement
Parking	Parking area for 2 vehicles adjacent to building.	No Requirement
Desk	(1) Office desk 30”H, 32”x60” desk top with 2 or more drawers on each side.	(1) Desk
Work Table	(1) Work table or bench	(1) drafting table minimum of 35 S.F.
Desk Chairs	(2) Swivel desk chairs	(1) Swivel desk chair. (2) Folding chairs.
Computer Equipment	(1) Computer	(1) Computer with high-speed internet.
Cleaning Supplies	Sufficient cleaning supplies	Cleaning supplies, broom, and dustpan are to be provided.

Note: Both states require testing equipment to perform the necessary tests.

3.4 Fabricator QC Requirements

This section compares the quality control requirements for fabricators (QC Manual, testing requirements, and the certification of the QC technician). The QC requirements are separated into prestressed (PSE) and non-prestressed (PCE) fabrication. Typically, the required level of certification for the quality control technician is different when the QC is for PSE as opposed to PCE.

3.4.1 Quality Control Manual/Quality Service Manual

The producer QCM/QSM requirements for PSE are similar between the six states as they all require that the facility be PCI certified and be following PCI MNL-116 guidelines. The only exception is the New Hampshire DOT which does not explicitly require a submittal of producer's QCM/QSM plan, however, they do require the fabricator to have a manual on hand that can be referenced at any time by inspector. Majority of agencies review producer's QCM/QSM once a year and/or prior to fabrication for the agency. The manuals are also reviewed whenever changes are made to them.

For PCE, majority of DOTs accept NPCA plant certification thus these states have QSM requirements laid out in NPCA certification manual. The NPCA website states that New Hampshire requires precast plants to be NPCA certified (NPCA Website, 2015). Maine DOT follows requirements put forth in AASHTO M157, these align with the requirements in NPCA certification manual.

Table 6 - Quality Service Manual

Agency	Prestressed QCM/QSM	Precast QCM/QSM
CT	PCI MNL-116	-
MA	PCI MNL-116	PCI MNL-116 or NPCA
ME	PCI MNL-116	NPCA or AASHTO M157
NH	PCI MNL-116	NPCA[1]
RI	PCI MNL-116	RIDOT requirements
VT	PCI MNL-116	NPCA

[1]As per NPCA (NPCA Website, 2015)

3.4.2 Quality Control Requirements

All New England states require QC requirements put forth in PCI MNL-116 for producers of PSE. The key QC and QSM requirements of PCI MNL-116 as they apply to this study are as follows:

- PCI MNL-116 requires at least one individual in the plant organization be certified as a PCI level 2 Technician/Inspector.
- Mix Design – Shall be specified in the project specifications
- Pre-Pour – The plant should prepare its own list of items to be checked with an emphasis on items that cannot be readily checked after concrete placement.
- Plastic Testing - preparation of concrete specimens for testing and performing slump, air content, compressive strength, and other concrete tests.
- De-stressing – force shall not be transferred to pretensioned members until concrete strength, as indicated by test cylinders or other properly calibrated non-destructive tests

techniques, is in accordance with the specified transfer strength. Typically, strengths ranging from 2,500 psi to 4,000 psi are acceptance for de-stressing.

- Stripping – Daily inspection of stripping product from the forms.
- Hardened – Compressive strength is tested as mentioned in concrete testing.
- Post – check finished product against approved shop drawings and plant standards to ensure proper dimensions, cast in items are correctly located, product is properly identified and marked, and all measurements are within allowable tolerances.
- Finish – inspection of finish to ensure the product matches the standard established by the plant and client.
- Transportation - None
- Non-conforming products – products that are damaged are to be recorded, marked, and re-inspected after being repaired.
- Constituent materials – suppliers of materials shall be required to furnish certified test reports for cement, aggregates, admixtures, curing materials, reinforcing and prestressing steel, and hardware materials, indicating these materials comply with the applicable ASTM standards, project specifications, and plant standards.
- Curing Requirements – the concrete in the form shall be maintained at a temperature of not less than 50˚F during the curing period (prior to stripping strength)
    - Accelerated Curing – The controlling temperatures shall be those actually achieved within the concrete elements.
    - Accelerated curing shall be started after the concrete has attained initial set. (ASTM C403, *Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance*)
    - The concrete temperature may be increased during the preset period at a rate not to exceed 10˚F per hour. The total permissible temperature gain during the preset period shall not exceed 40˚F higher than the placement temperature or 104˚F, whichever is less.
    - A heat gain not to exceed 36˚F per hour, measured in the concrete, is acceptable provided the concrete has attained initial set.
    - The maximum curing temperature shall no exceed 180˚F.

The following tables detail the QC procedures associated with PCI MNL-116 that all of the New England States require PSE fabricators to adhere to. The first table, Table 7, summarizes the frequency of plastic testing required by PCI MNL-116 which includes slump, air, unit weight, and temperature. The remaining tables provide information on the testing frequencies required for compression cylinder casting and testing, coarse and fine aggregates, cementitious materials, and both reinforcing steel and prestressing strands.

The minimum frequency of plastic tests as per PCI MNL-116 are found in the following table. The frequency of testing is mainly reliant on when cylinders are cast. However, PCI MNL-116 specifies the minimum frequency of slump testing to be once per day.

Table 7 – QC Plastic Concrete Test Frequencies as per PCI MNL 116

Test	Frequency
Slump	At the start of operations each day, when making strength specimens, when the consistency of the concrete appears to vary, at least one per every three air content tests
Air Content	Minimum of one daily check per mix design or when making strength cylinders
Unit Weight	At least once per week
Temperature	When slump, air, or strength cylinders are made

Table 8 provides the minimum frequency and the number of cylinders to be cast. PCI MNL-116 requires at least four cylinders cast for each mix design or for every 75 cubic yards of production of a particular mix.

Table 8 – QC Number and Frequency of Cylinder Casting as per PCI MNL 116

QSM	Number and Frequency of Cylinder Casting
PCI MNL-116	Four (4) compression cylinders shall be made daily for each individual concrete mix, or for each 75 CY of a given mix design

Aggregate sampling frequency is determined by weight of production. As shown below, coarse aggregate is required to be sampled and tested every 1,000 tons while fine aggregate is sampled and tested every 500 tons.

Table 9 – QC Aggregate Sampling Frequency as per PCI MNL 116

Aggregate Size	Frequency
Coarse	Every 1,000 tons
Fine	Every 500 tons

Where the volume of aggregate used in one-week period is less than specified above, the minimum rate of testing shall be one test per week per aggregate size or type.

Cementitious materials are not specifically required to be tested for QC purposes by PCI MNL-116. However, this is only the case if the mill reports are provided. If the mill reports are not provided for a given shipment, the cementitious materials must be tested accordingly and documented.

Table 10 – QC Frequency of Cementitious Material Testing as per PCI MNL 116

	Frequency
Cementitious Materials	If mill certificates are not provided, testing should be performed on each shipment

Similar to the cementitious material testing requirements, reinforcing steel and prestressing strands are not required to be tested for QC purposes if the mill reports are provided. If the mill reports are not provided, the steel used in either PSE or PCE should be tested in accordance with ASTM A370.

Table 11 – QC Reinforcing Steel and Prestressing Strand Testing as per PCI MNL 116

	Frequency
Reinforcing Steel and Prestressing Strands	Testing is not required if mill reports are provided. If mill reports are not provided, it should be tested in accordance with ASTM A370

For PCE, a few of the New England states require the QC processes put forth by NPCA. The key QC and QSM requirements of NPCA as they apply to this study are as follows:

- NPCA requires that Plant QC Inspectors and assigned back up inspectors hold current certificates of completion for NPCA Production and Quality School and ACI Concrete Field Testing Technician Grade 1.
- Mix Design – Concrete mixes shall be proportioned in accordance with ACI 211.1 – 211.3. Mix proportions shall be determined by a commercial laboratory, project specifications, or by qualified precast plant personnel.
- Pre-Pour – inspections shall be performed prior to casting each form. Form dimensions, tightness, cleanliness, release agent application, positioning and securing of reinforcing, embedded items and block outs shall be checked.
- Plastic Testing – Slump, Air Content, and Temperature are measured every 150 CY or daily, whichever comes first.
- Stripping – Products shall not be removed from the forms until the concrete reaches the designed compressive shipping strength. If no such requirement exists, the plant shall define product-specific minimum shipping strengths that must be obtained prior to stripping.
- Hardened Tests – Compressive strength cylinders are casted every 150 CY or weekly, whichever comes first.

- Post-Pour – A post-pour inspection shall be made of each product. The inspections shall document any damage, excessive bugholes or honeycombing, poor dimensional tolerances, or other problems such as exposed reinforcing. A mark shall be made on the product indicating whether it is acceptable, requires repair, or if it has been rejected.
- Finish – appearance of concrete shall match approved samples and meet industry standards.
- Transportation – Final inspection is to be performed prior to shipping of the element.
- Non-conforming – The plant shall have documented procedures for repair of damaged products, including procedures for repair of honeycombing, excessive air voids, and minor and major defects. The procedures shall list acceptable repair products to be used.
- Constituent Materials – Documentation shall be maintained current in the plant records for the following:
  - Cement and supplementary material mill certificates
  - Aggregate supplier and test reports
  - Mix water potability test reports or other test records indicating the acceptability of the mix water (annually) unless using municipal water supply
  - Chemical admixture and other additive certifications (annually).
  - Tests for aggregate gradation and deleterious substances shall be performed at minimum frequency.
- Curing Requirements
  - If products are cured with heat and moisture in order to accelerate the strength gain, the ambient curing temperature shall be monitored during the curing period at least once per week. Temperature records shall be maintained in the plant records.
  - If heat curing is used, the necessary initial-set period shall be determined.
  - Products cast outdoors or in dry conditions shall be protected from moisture loss by application of a curing compound, moist curing or impervious sheeting.
  - The QC Inspector shall inspect curing of products and exposed surfaces of stripped products for evidence of plastic cracking. Damage shall be documented.

The following tables summarize the QC requirements put forth by NPCA for frequency of sampling and testing of materials and mixes. The tables detail sampling and testing frequencies for plastic concrete, compression cylinders, coarse and fine aggregates, cementitious materials, and reinforcing steel.

The frequency of testing slump, air content, unit weight, and concrete temperature follow similar requirements. Slump, air content, and unit weight are required to be sampled and tested every 150 cubic yards or once per week, whichever comes first. The temperature of the concrete does not have a specific frequency, however, it is reliant on the sampling and testing of the other plastic tests.

Table 12 – QC Plastic Concrete Test Frequencies as per NPCA

Test	Frequency
Slump	150 CY of concrete or once per day, whichever comes first
Air Content	150 CY of concrete or once per day, whichever comes first
Unit Weight	150 CY of concrete or once per week, whichever comes first
Temperature	When slump, air, or strength cylinders are made

NPCA QC procedures require four cylinders to be cast for every 150 cubic yard of a particular mix design that is produced. The minimum requirement of sampling and testing is once per week.

Table 13 – QC Number and Frequency of Cylinder Casting as per NPCA

QSM	Number and Frequency of Cylinder Casting
NPCA	Four (4) cylinders shall be made for each 150 CY of concrete for each mix or once per week, whichever comes first

Aggregates are sampled and tested at a weight based frequency of every 2,000 tons for coarse aggregates and every 1,500 tons for fine aggregates.

Table 14 – QC Aggregate Sampling and Testing Frequency as per NPCA

Aggregate Size	Frequency
Coarse	Every 2,000 tons
Fine	Every 1,500 tons

NPCA QC procedures do not require cementitious materials to be sampled and tested. The mill reports should be provided to the plant for every shipment of cementitious materials for documentation and use by both the fabricator and the agency inspector.

Table 15 – QC Cementitious Material Testing as per NPCA

	Frequency
Cementitious Materials	Mill reports shall be provided with each shipment

Reinforcing steel is not required to be sampled and tested as per NPCA QC manual. However, the mill reports must be provided with each shipment for use by both the fabricator and the agency inspector.

Table 16 – QC Reinforcing Steel Sampling and Testing as per NPCA

	Frequency
Reinforcing Steel and Prestressing Strands	Mill reports shall be provided with each shipment

3.4.3 Quality Control Technician Qualification

The Quality Control Technician qualification requirements were found to have some similarities. However, the level of certification is not entirely unified as shown in Table 17. All New England states require the PSE producing plant to be PCI certified, thus QC technician requirements are PCI Level-2 for all of them. Furthermore, PCI recommends that at least one QC personnel to be also PCI Level-3 certified at the plant. The discrepancy is mostly found in QC personnel qualification for PCE. The requirements vary between ACI and PCI certifications and also the required level of certification. All agencies require all inspectors to be tested as part of Independent Assurance (IA) system for the tests that they are required to be conducted. These typically include: slump or spread for workability, air content, casting of test cylinders and sampling of material.

Table 17 - Quality Control Technician Qualification

Agency	**Prestressed QC Technician Qualification**	**Precast QC Technician Qualification**
CT	PCI Level 2	ACI Level 1
MA	PCI Level 2	ACI Level 1 or 2
ME	PCI Level 2	PCI Level 1 or 2 (depending on element)
NH	PCI Level 2	PCI Level 2
RI	PCI Level 2	-
VT	PCI Level 2	-

3.4.4 Additional QC Requirements per Agency specifications

The following section describes the additional requirements put forth by each agency in addition to the requirements of PCI MNL-116 or NPCA plant certification. These requirements are primarily for QC testing of plastic concrete properties, compression strength cylinder casting and testing, aggregate sampling and testing, cementitious material testing, and reinforcing steel.

All New England agencies require PCI MNL-116 as the QSM for PSE. The QSM for Structural PCE is mixed amongst the states varying between PCI MNL-116 and NPCA. Non-Structural PCE is fairly consistent amongst the agencies to follow NPCA. Currently, none of the agencies require plastic concrete or aggregate sampling and testing in addition to the requirements put forth by PCI MNL-116 or NPCA. Maine DOT requires compression cylinders to be cast at a minimum frequency of each day's cast and for each form bed used in production. Rhode Island requires that mill test reports must be submitted for each shipment of cementitious materials. However, this specification is also included in the QSM (PCI MNL-116 and NPCA). Rhode Island DOT also includes an additional requirement for the QC procedure of prestressing strands and reinforcing steel. It is required to provide a mill test report and one certificate of compliance per shipment, per size, per source, per heat number.

Table 18 - PSE - Agency QC Requirements in Addition to PCI/NPCA QSM/QCM Requirements

QC Aspect	Agencies with Additional Requirements for PSE
Plastic Concrete Testing	None
Compression Cylinders	ME
Aggregates	None
Cementitious Materials Sampling and Testing	RI
Prestressing Strands or Reinforcing Steel Sampling and Testing	RI

3.5 Agency Inspection

The details of the inspection process implemented by each state are presented in this section. The first two sections compare the use of consultant inspectors versus employee inspectors along with the required certification of the inspectors. This section also details the inspection processes including mix design, pre-pour, plastic testing, de-stressing, form stripping, hardened concrete tests, post-pour, finishing, and transportation for PSE, Structural PCE, and Non-Structural PCE. Figure 3 shows the QA inspector and QC technician witnessing the prestressing of strands as a part of the pre-pour inspection. The sampling frequencies of constituent materials is detailed including aggregates, steel, and cementitious materials.

Figure 3 - Pre-Pour Inspection at Oldcastle Precast in Rehoboth MA (Left to right: QA Inspector, QC Technician and Producer Employee)

3.5.1 Employee versus Consultant Inspection

The study showed that a full spectrum of practices exist when it comes to consultant versus employee inspectors. Connecticut, Vermont, and Maine all used a combination of both in-house and consultant inspectors. Massachusetts and New Hampshire use only consultant inspectors while Rhode Island uses only in-house inspectors.

Table 19 - Employee versus Consultant Inspectors

Agency	Inspector Category
CT	Both
MA	Consultants
ME	Both
NH	Consultants
RI	Employees
VT	Both

Figure 4 - Map of Consultant vs Employee Inspectors

3.5.2 Inspector Qualification

The inspector qualification specification shows limited unification between the states. For PSE, most states require some level of PCI certification. Massachusetts, Maine, and New Hampshire require the same level of certification for their prestressed inspectors (PCI Level 2). Vermont and Connecticut both require a level 1 certification (PCI for VT and ACI for CT). For Connecticut DOT employees (in-house inspectors) the training through University of Connecticut certification program is typically conducted. For PCE inspectors, most states do not distinguish between the requirements, however Maine allows for PCI level 1, 2 or 3 certification for the inspectors. Massachusetts allows their in-house employee to have NETTCP certification. The main difference is found in the requirements of the Rhode Island DOT as they provide their own in-house certification program for all of their inspectors.

Table 20 - Inspector Qualification

Agency	Prestressed Inspector Qualification	Precast Inspector Qualification
CT	ACI level 1 equivalent	ACI level 1 equivalent
MA	PCI Level 2	Consultants – PCI Level 2 MADOT - NETTCP
ME	PCI Level 2	PCI Level 1, 2, or 3
NH	PCI Level 2	PCI Level 2
RI	In-House Certification	In-House Certification
VT	PCI Level 1	PCI Level 1

3.5.3 Inspection Process

3.5.3.1 Mix Design

The process of developing and approving mix designs for the elements are comparable between the states. However, the mix requirements themselves vary substantially amongst the states. This was best demonstrated during the visits made to J.P. Carrara in Vermont and Oldcastle in Rehoboth Massachusetts. The standard practice is for each state to approve mix designs that are submitted to them by the producer. This led to multiple mix designs being used on a project-to-project basis. The elements will be exposed similar climatic conditions and are used in similar applications, it is believed that a fewer mix designs can be created and implemented to allow for lower number of mixes that the contractor is responsible for producing and also aid in expediting the quality assurance process.

3.5.3.2 Pre-Pour

The study showed strong similarities for the pre-pour inspection processes between all six of the states. In most cases, the inspector works side by side with the quality control technician to inspect all aspects of the element. For this process, it was asked of each agency to provide a pre-pour inspection checklist that is provided to the inspector for both PSE and PCE. A sample of a pre-pour inspection checklist is provided below. The remaining checklists can be found in APPENDIX-F.

Table 21 - Maine DOT Pre-Pour Checklist

Item	Check For	Checked
Calibrations	Cement Scales – Date of Last Calibration	
	Aggregate Scales – Date of Last Calibration	
	Water Meter – Date of Last Calibration	
	Stressing Jack – Date of Last Calibration	
	Cylinder Compression Tester – Date of Last Calibration	
Pre-Stressing Strand	Domestic Origin	
	Coil Identification	
	Cross Sectional Area	
	M.O.E.	
	Stressing Calculations	
	Size (diameter)	
	Strand Pattern in Form	
	Lateral Location	
	Vertical Location	
	Clean of Contaminants	
	Elongations	
Reinforcing Steel	Domestic Origin	
	Confirm Manufacturer	
	Bar Size	
	Bar Dimensions	
	Bar Location in Form	
	Projection Above Form	
	Bar Quantities	
	Clearance	
	Dielectric Chairs (epoxy coated steel)	
	Certificate of Conformance for Epoxy Coating	
	Splice Lap Lengths	
	Coated Tie Wire (epoxy steel)	
	Clean of Contaminants	

Form	Length	
	Width	
	Height	
	Shear key Dimensions	
	Chamfers	
	Dowel Pin Tube Locations	
	Post Tensioning Duct Size/Locations	
	Post Tensioning Duct Block out Size (Fascia Beams)	
	Excess Form Oil to be Dry Mopped	
	Form Ties and Inserts to be Recessed 1 inch Minimum	
	Void Dimensions	
	Void Location – Lateral, Vertical and End	
	Void Location After Concrete Placement - Witness QC Checking Location After Hold Downs are Removed	

3.5.3.3 Plastic Concrete Testing

Through this study it was shown that the states have different requirements regarding who performs the plastic concrete tests. In some cases, the inspector is present at the plant in order to witness that the Quality Control testing is performed correctly and the results are accurate. Contrary to that, other states require their inspectors to perform their own plastic concrete tests and compare those results to the results obtained by the QC technician. The following table (Table 22) shows the requirements of the inspector witnessing the testing versus the inspector performing the testing themselves.

Table 22 - Witness versus Perform Testing

Agency	Witness versus Perform Testing
CT	Witness
MA	Perform
ME	Perform
NH	Perform
RI	Perform
VT	Perform

Figure 5 – Map of Witness vs Perform for Agency Inspection

In addition to the requirements for each state varying in regards to the plastic concrete testing being witnessed by inspectors or the inspectors performing the tests themselves, the frequencies of the plastic testing were also found to be different amongst the six states.

The requirements for testing includes workability testing (slump or flow), air content measurement, and measuring the temperature of the fresh concrete. Workability is to be tested per AASHTO T119, "Standard Test Method for Slump of Hydraulic-Cement Concrete." The air content of the mix is to be measured by AASHTO T152, "Air Content of Freshly Mixed Concrete by the Pressure Method." Temperature can be measured by AASHTO T309, "Temperature of Freshly Mixed Portland Cement Concrete."

The following tables (Table 23, Table 24, Table 25) show the frequency of testing of fresh properties of concrete for PSE, Structural PCE, and Non-Structural PCE. The frequency requirements are not very similar amongst the states. The frequency requirements fall under one of the three categories: per sublot, consistency based sampling, and a volume based method. The consistency based sampling method involves the initial testing of the first two batches and if the specified criteria is met, the frequency of the sampling can be decreased. In most cases, the sampling should not exceed every third batch. However, if the sampling provides inconsistent results, the frequency of sampling can increase until the results are stable. The Connecticut DOT requires the inspector to witness the QC testing. Therefore, the frequency of testing is determined by the QC requirements and the specified frequency. For non-structural PCE, use of volume based sampling frequency might be better suited as opposed to use of sampling method as function of element or per pour. For example, in case of smaller items such as catch basins, excessive sampling and testing might be necessary if per item sampling is conducted.

The following sections will detail the inspection testing and frequencies required by each agency broken into the categories of PSE, Structural PCE, and Non-Structural PCE. The agency inspection processes will be tabulated based upon the stage of inspection and will be shown in the order of PSE, Structural PCE, followed by Non-Structural PCE.

Table 23 - Frequency of Plastic Concrete Tests for PSE

Agency	Spread	Air Content	Temperature
CT	Use QC Results		
MA	Once per pour		
ME	When cylinders are cast		
NH	Per sublot (typ. 1/item and typ. < 50 CY)		
RI	Once per 150 CY or each day's production		No Temperature Test
VT	First load + whenever cylinders are cast		

NH DOT also require w/c ratio testing using microwave method.

Table 24 - Frequency of Plastic Concrete Tests for Structural PCE

Agency	Spread	Air Content	Temperature
CT	Use QC Results		
MA	Once per pour		
ME	When cylinders are cast		
NH	Per sublot (typ. 1/item and typ. < 50 CY)		
RI	Once per 150 CY or each day's production		No Temperature Test
VT	First load + whenever cylinders are cast		

Table 25 - Frequency of Plastic Concrete Tests for Non-Structural PCE

Agency	Spread	Air Content	Temperature
CT	Use QC Results		
MA	Once per pour		
ME	When cylinders are cast		
NH	Per sublot (typ. 1/item and typ. < 50 CY)		
RI	Once per 150 CY or each day's production		No Temperature Test
VT	First load + whenever cylinders are cast		

3.5.3.4 De-stressing of Prestressed Elements

The inspection of prestressed elements was found to be similar amongst the six agencies. The process is driven by the QC requirement that most states require the plant to follow which is PCI MNL-116. However, the study showed a discrepancy in the inspection of the de-stressing process between agencies. Most agencies require their inspector to be present during the de-stressing while Connecticut DOT does not require their inspector to be present (refer to Table 26). The PSE camber measurements are also conducted soon after destressing and majority of inspectors observe QC personnel conduct the camber measurements.

Table 26 – Witness De-stressing

Agency	Present for De-stressing
CT	No
MA	Yes
ME	Yes
NH	Yes
RI	Yes
VT	Yes

3.5.3.5 Post-Pour

All agencies require the post-pour inspection of the product. Figure 6 below shows an example of an inspector witnessing the QC technician measure the camber of a prestressed beam element. Table 27 shows the inspector's checklist for post-pour inspection from the Maine DOT (The checklists from various states are attached as APPENDIX-F). Although the states differ slightly in the post-pour inspection process, this particular checklist covers most of the areas required by the remaining agencies.

Figure 6 - Post-Pour Inspection; QA Inspector Observing QC Personnel Measure Camber after Destressing Bulb-Tee. (image taken at J.P. Carrara and Sons facility by researchers during site visit)

Table 27 - Maine DOT Post-Pour Inspection Checklist Items

Length
Width
Height
Sweep
Camber
Fascia Surface Finish
Interior Beam Finish
Top Finish
Void Drains Opened
Cold Joints/Laminations
Cracks/Chips/Spalls
Concrete Cleaned from Exposed Reinforcing
Chamfer Smoothness/Uniformity
Post Tensioning Duct Locations
Unit Identification

The standard grade finishing of products is included in PCI MNl-116. However, some states finishing specifications include additional requirements. For example, the Maine DOT includes a fascia surface finishing specification.

3.5.3.6 Hardened Concrete

The following tables (Table 28, Table 29, Table 30) shows the frequency that compressive strength cylinders are cast per the requirements of each state. The casting and testing of compressive strength cylinders follows AASHTO T22, “Compressive Strength of Cylindrical Concrete Specimens.”

Table 28 – Frequency and Number of Compressive Strength Test Cylinders for PSE

Agency	Frequency and Number of Test Cylinders
CT	Minimum of 1/day
MA	Once per 150 CY or each day's production. 8 Cylinders – 2 for 7-day, 2 for 28-day, and 3 for 56-day
ME	2 cylinder/week for process control. 6 with permeability requirements (8 per each continuous placement cast for acceptance)
NH	Once per sublot. Minimum of 2 per placement at 28-days
RI	4 cylinders <100 CY, 6 cylinders >100 CY or per day of production
VT	Once per casting bed. 6 cylinders for Detensioning, 4 cylinders for 28-day (all testing by fabricator, witnessed by QAI)

Table 29 - Frequency and Number of Compressive Strength Test Cylinders for Structural PCE

Agency	Frequency and Number of Test Cylinders
CT	Minimum of 1/day
MA	Once per 150 CY or each day's production. 5 cylinders
ME	2 cylinder/week for process control. 6 with permeability requirements (8 per each continuous placement cast for acceptance)
NH	Once per sublot. Minimum of 2 per placement at 28-days
RI	4 cylinders <100 CY, 6 cylinders >100 CY or per day of production
VT	Once per casting bed. Minimum of 4 cylinders. 2 at 7-day and 2 at 28-day

Table 30 - Frequency of Compressive Strength Test Cylinders for Non-Structural PCE

Agency	Frequency and Number of Test Cylinders
CT	Minimum of 1/day
MA	Once per 150 CY or each day's production. 5 cylinders
ME	2 cylinder/week for process control. 6 with permeability requirements (8 per each continuous placement cast for acceptance)
NH	Once per sublot. Minimum of 2 per placement at 28-days
RI	4 cylinders <100 CY, 6 cylinders >100 CY or per day of production
VT	Once per casting bed. Minimum of 4 cylinders. 2 at 7-day and 2 at 28-day

Additional hardened concrete tests are performed by the Maine and New Hampshire DOTs. Both agencies perform permeability testing of the specimen using AASHTO T-358 "Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration."

It is preference of most agencies that QA inspector witness the loading of the elements on to the transportation vehicle, but most of the agencies allow exceptions to this requirement. The exceptions are allowed since it is difficult to witness loading of elements in instances where there is time lag associated with element fabrication and its actual transport to construction site. The agencies have different mechanisms to indicate compliance of the element to specifications by inspectors. For example, Rhode Island and Vermont uses stamps on the elements, Rhode Island also uses plastic identification tags with serial number for that are embedded into the element. On the other hand, Massachusetts inspectors issue a paper certificate of compliance at the time of element departure from the fabricator facility. At present, Massachusetts is also exploring use of radio-frequency identity (RFID) tags for purposes of tracking the fabrication, QA process and delivery of PCE and PSE. Such method with use of cloud-based storage can substantially stream-line the management of QA data and processes associated with compliance evaluation.

3.5.3.8 Non-Conformance Reports

Non-conformance inspection and reporting was found to be similar amongst the states. The basic process adopted by each state included the documentation of the defect followed by the fabricator producing and submitting a Non-Conformance Report (NCR) to the agency. After, depending on the criticality of the defect, the submitted repair plan is either accepted or rejected by the design engineer. The majority of the state agencies allow the repair of PSE as per PCI guidelines.

3.5.4 Sampling of Constituent Materials

This section discusses the sampling and testing of constituent materials (aggregate, cement, steel etc.) as part of the QA process. The sampling and testing frequencies discussed here are those put forth by agencies for QA inspectors to use for purposes of verification.

Aggregate Sampling and Testing

The frequencies for inspector sampling and testing vary significantly between agencies. The study showed the full spectrum of testing frequencies for both fine aggregates and coarse aggregates.

Table 31 - Aggregate Sampling for PSE

Agency	**Aggregate Sampling**	
	Coarse	**Fine**
CT	Monthly or as directed by engineer	Monthly or as directed by engineer
MA	Once per year	Once per year
ME	Not specified	Not specified
NH	Prior to concrete operations	Prior to concrete operations
RI	Once per 150 CY for gradation[1]	Once per 150 CY for gradation[2]
VT	Once every other day of production	Once every other day of production

[1] Require one 150 lb sample per year for L.A. Abrasion Tests, a sodium sulfate soundness test, specific gravity, and unit weight measurements.

[2] Require one 50 lb sample per year for gradation (fineness modulus)

Table 32 - Aggregate Sampling for Structural PCE

Agency	Aggregate Sampling	
	Coarse	**Fine**
CT	Monthly or as directed by engineer	Monthly or as directed by engineer
MA	Once per year	Once per year
ME	Not specified	Not specified
NH	Prior to concrete operations	Prior to concrete operations
RI	Once per 150 CY for gradation[1]	Once per 150 CY for gradation[2]
VT	Once every other day of production	Once every other day of production

[1] Require one 150 lb sample per year for L.A. Abrasion Tests, a sodium sulfate soundness test, specific gravity, and unit weight measurements.

[2] Require one 50 lb sample per year for gradation (fineness modulus)

Table 33 - Aggregate Sampling for Non-Structural PCE

Agency	Aggregate Sampling	
	Coarse	**Fine**
CT	Monthly or as directed by engineer	Monthly or as directed by engineer
MA	Once per year	Once per year
ME	Not specified	Not specified
NH	Prior to concrete operations	Prior to concrete operations
RI	Once per 150 CY for gradation[1]	Once per 150 CY for gradation[2]
VT	Once every other day of production	Once every other day of production

[1] Require one 150 lb sample per year for L.A. Abrasion Tests, a sodium sulfate soundness test, specific gravity, and unit weight measurements.

[2] Require one 50 lb sample per year for gradation (fineness modulus)

Cementitious Materials Sampling and Testing

The sampling frequencies of cementitious materials among the states vary from specifying a distinct frequency to requiring the cementitious materials to be tested every two weeks. Since the majority of the plants perform fabrication for multiple agencies, a unified specification for the sampling and testing of the cementitious materials would aid in the QA of the product along with providing clarity to the fabricator on the sampling procedures.

Table 34 - Cementitious Materials Testing Frequencies for PSE

Agency	Cementitious Materials
CT	Mill reports provided as directed by engineer
MA	Annually
ME	Mill reports provided monthly
NH	Mill reports with each delivery
RI	One sample every two weeks
VT	At beginning of job or annually, samples from every delivery provided to agency

Table 35 - Cementitious Materials Testing Frequencies for Structural PCE

Agency	Cementitious Materials
CT	Mill reports provided as directed by engineer
MA	Annually
ME	Mill reports provided monthly
NH	Mill reports with each delivery
RI	One sample every two weeks
VT	At beginning of job or annually, samples from every delivery provided to agency

Table 36 - Cementitious Materials Testing Frequencies for Non-Structural PCE

Agency	Cementitious Materials
CT	Mill reports provided as directed by engineer
MA	Annual
ME	Mill reports provided monthly
NH	Mill reports with each delivery
RI	One sample every two weeks
VT	At beginning of job or annually, samples from every delivery provided to agency

Steel Sampling and Testing

Steel testing was found to be done on specimens obtained using random number based sampling for the majority of the states. In some cases, the sampling and testing of steel was not specified. The common practice amongst the states was to obtain samples in random increments throughout the year and perform the testing at the central labs. Massachusetts does not require a specific sampling frequency, however, it is required in the specifications to sample and test prestressing strands or reinforcing steel at a rate that is sufficient to check conformance.

Table 37 – Prestressing Strands Sampling and Testing

Agency	Prestressing Strand Sampling and Testing
CT	Before placement in element, a minimum of one 7 foot sample and one 1 foot sample
MA	Random number based sampling
ME	Not specified
NH	Mill report must be provided
RI	One samples per size, per source, per year for a tension test
VT	Before pour and compared to mill certifications

Table 38 - Reinforcing Steel Sampling and Testing for Structural PCE

Agency	Steel Sampling and Testing
CT	One sample of each size from each source per project
MA	Random number based sampling
ME	Not specified
NH	Not specified
RI	Two samples per size, per source, per year for a tension and bend test
VT	Before pour and compared to mill certifications

Table 39 - Reinforcing Steel Sampling and Testing for Non-Structural PCE

Agency	Steel Sampling and Testing
CT	Every 6 months or as directed by engineer
MA	Random number based sampling
ME	Not specified
NH	Not specified
RI	Two samples per size, per source, per year for a tension and bend test
VT	Before pour and compared to mill certifications

3.5.5 Estimated Inspection Cost

A component of the study included determining the cost of quality assurance inspection to aid in development of a cost-share mechanism between agencies. The agencies provided an hourly cost estimate for the consultant inspectors. It was found that the hourly rate of the consultant inspectors ranged from approximately fifty dollars per hour to one hundred dollars per hour. The lower end of the spectrum does not include travel costs of the inspectors as the higher end does include travel reimbursement. This data will be utilized in proposing a cost-sharing mechanism for states to cross-utilize inspection resources.

3.6 Curing Requirements

The requirements for curing were found to range from well-prescribed requirements to not being included in inspection process. The Maine DOT included the most stringent curing requirements. The specification they use for curing requirements follows PCI MNL-116 with the addition of exceptions. The highlights of the specification is shown in Table 40. A commonality found throughout the study was that most states allowed accelerated curing for PSE but did not for PCE.

Table 40 - Curing Requirements

Agency	Curing Requirements
CT	Not Inspected – Follow MNL-116
MA	-
ME	MNL-116 with exceptions. • Temperature gain <40˚F/hr. • Initial set determined by ASTM C403 • Maximum temperature of 160˚F • Minimum temperature of 120˚F • Until 80% of design strength is achieved
NH	Item Specific
RI	Accelerated curing allowed for PSE
VT	-

4. Plant Certification and Producer Testing Requirements

4.1 Certification Manuals

4.1.1 PCI and NPCA

The two broad types of certifications that manufacturers can obtain depending on the element that they produce are PCI and NPCA. Although these certifications are both issued for precast concrete elements manufacturers, the main focus of PCI is the pre-stressed concrete elements while NPCA mainly issues certifications for other precast concrete products. Recently, the two organizations have also signed a strategic partnership document that helps in reducing the duplication problems especially for the manufactures that already produce precast and pre-stressed concrete elements under NPCA certification but are required to have PCI certificate to produce pre-stressed elements.

4.2 Pre-stressed Elements

4.2.1 Plant Certification Requirements

4.2.1.a Plant Certification Manual

As previously discussed, PCI manual will be applied to all the manufactures that are currently producing pre-stressed elements even though they might already have the NPCA certificate.

The specific manual for producing pre-stressed elements is the PCI-MNL-116 which is a comprehensive guide to produce high quality pre-stressed elements. Also in situations that there is a need to repair such elements the guidelines of PCI-MNL-137 which is specifically designed in this regards should be followed.

The PCI manual contains different categories for diverse types of precast concrete structures. These are called B and C groups each divided to sub groups designed for different structural purposes. Groups B2, B3 and B4 are specifically designed for pre-stressed bridge elements while C2, C3 and C4 can be used for commercial/structural products.

Along with the PCI requirements there are additional recommendations from the researchers contributing in this report to enable the manufactures and agencies of different New England states have a unified QA process that is also close to what they follow at the time being.

4.2.1.b *QC Personnel Qualifications*

In terms of QC personnel qualifications, the minimum requirement of PCI manual is a level 2 certificate, but the recommendation in this research is also to deploy personnel who own a level 1 PCI certificate with an experience of minimum 4 years related to pre-stressed elements manufacturing under intermittent supervision of a level 2 certificate holder.

4.2.1.c Office Requirements

The inspector office and facilities provided by Rhode Island DOT are the most comprehensive and the only extra requirements are the internet connection and a meeting table. These facilities should be adopted as a standard in the unified specification with the addition of office sharing amongst the agencies.

4.2.1.d Miscellaneous

4.2.1.d.1 Safety

Along with the technical requirements of any plant that follows any type of manufacturing manual it is of high importance for the manufacturer to maintain safety in the plant for the its own personnel as well as agency's inspector. For this reason it is strongly advised that the manufacturer get use of at least one subject matter expert Health, Safety and Environment (HSE) personnel with related safety certificate to design a safety plan and have the other personnel trained for emergency conditions. In regards with pre-stressed elements, one of the high risks is when the strands are getting into tensioning, since there is a high amount of potential stress in the strands there is the possibility of strand breakage and release due to loose grips. So, it is suggested to get use of screens around the pre-stressed elements that have undergone tensioning but still have not been filled with concrete.

4.2.1.d.2 Cement storage silos

Cement is probably the most expensive and less durable material in any concrete production process. The quality of cement highly affects the properties of final product, therefore care must be taken in its storage manner as well as the time it is stored in silos. Cement is prone to expand in high temperatures so the storage silos should not be fully filled with cement. The recommended empty space is 5% of the silo volume. Also storage duration should not be more than three months since the cement might undergo corruption. In such cases the stored cement should be tested for quality control before it is actually used in the construction process. Table 41 summarizes the plant inspection recommendations for pre-stressed manufactured elements.

Table 41 - Plant Inspection Requirements for Pre-Stressed Elements

Plant Inspection	Recommendations
Certification	PCI
QC Qualification	PCI Level 2 or PCI level one with 4years of subject experience under intermittent supervision of a level2
PCI Groups	B2, B3, B4, C2, C3, C4
Office Requirements	RI DOT with office sharing and internet
QSM	PCI MNL-116 and PCI MNL-137 for concrete repair
Miscellaneous	Providing Safety plan and letting 5% of cement storage silos be empty for expansion

4.2.2 Plant Sampling and Testing Requirements

Concrete is a material that its final quality is highly affected by its production procedure. There are numbers of different tests that have been assigned for concrete to assure its quality in terms of the required load bearing capacity as well as its durability, workability and surface texture. These tests are conducted in three different steps of production procedure. Before the start of actual concrete production in high volumes, the mix design should be tested in much lower volumes to prevent probable economical drawback of low quality concrete in high volumes. The three different stages of concrete testing are Pre-Pour, During Pour and Post Pour that will be discussed in this report.

4.2.2.1 Pre-Pour

The Pre-Pour level is actually the stage of testing the ingredient material such as aggregate, cement, water, and other possible chemical and mineral admixtures in the concrete along with validating the mixture design and final product in regards with its physical properties that should be maintained constant during the concrete casting procedure. This process will guarantee a final concrete product with the required level of quality. The other important factor in determining that whether the produced concrete has a consistent quality during the production is the number of frequency of tests that should be performed on it. Concrete is a heterogeneous material and if not mixed properly it might reveal unexpected early cracks during its life time. So, this fact makes the number of sampling critical in regards with delivering a quality and well mixed product.

4.2.2.1.a Aggregate

Aggregate forms the main structure of the concrete since it is the main load bearing component in concrete and accounts for nearly 75% of its total volume. The aggregate should be clean and strong and free from harmful mineral chemicals like iron sulfides, ferric and ferrous oxides that might cause distress in Portland Cement Concrete. The aggregate should also be free of any clay and contamination which will avoid the coating of aggregate particle by cement during the mixing procedure. Aggregate in concrete include the coarse and fine particles and its selection affects the final texture as well as workability of concrete along with the durability and abrasion resistance of concrete. Table below shows the frequency of aggregate testing for pre-stressed concrete elements.

Table 42 - Pre-stressed - Aggregate Testing QC Recommendations

Aggregates	PCI Requirements	Addition to PCI/Explanations	Remarks
Coarse	Every 1,000 tons	At least every one week	Whichever comes first
Fine	Every 500 tons	At least every one week	Whichever comes first

4.2.2.1.b Cementitious Material

Cementitious material are the ones that when compound with water form a glue that holds the aggregate in the concrete together. The main cementitious material in concrete is the Portland cement and others vary from different grades of fly ash to silica fume and different types of natural pozzolans. Depending on the type of these material in the mixture there are certain types of tests that should be conducted on them to evaluate their quality and compatibility with other material and especially aggregate in concrete. Usually these tests are done in the laboratory of the cementitious material producer factory that takes the responsibility of its product quality. The producer issues mill reports that contain information about the results of tests conducted on the material. The pre-stressed concrete element manufacturer should supply these materials in the plant by a member of qualified product list and should submit the mill report to the QA inspector whenever required. If the mill report is provided, no other test is required.

4.2.2.1.c Water

The quality of water used in concrete mixing process is of high importance since the chemicals in water directly affect the cement setting time, concrete durability and final strength. Generally, the water used in the concrete should be appropriate for drinking. In plant the quality control test on water should take place at least once per year or whenever the source of water changes in accordance to ASTM C1602 or AASHTO T26 standard.

4.2.2.1.d Pre-stressing strands

During the tensioning process, pre-stressing strands stretch in length, and their cross section decreases while the tensioning is in progress. This results in a large amount of tensile stress. The supplier of the pre-stressing strands should be among the qualified product producer list and the product should come with the mill report. Even if the mill report is provided the product should be tested in accordance with ASTM A370 or AASHTO T244 standard. The prevailing amount of pre-stressed concrete elements are manufactured by use of seven wire pre-stressing strands. For these types of strands the ASTM A416 or AASHTO M203 standard is the required quality control test. For testing purposes, a two meter long sample should be selected per heat number.

4.2.2.1.e Concrete Unit Weight and Air Content

The concrete used in pre-stressing elements should be of proper high density, since after the strands are released, they compress the concrete and convey the pre-tensioning stress to concrete. The concrete unit weight is a direct function of concrete ingredient material like aggregate and cement. The unit weight test should be done each time the mixture design changes and also when the source of aggregate changes. In the manufacturing process the concrete unit weight should be tested at least once per week in plant.

The produced concrete also should contain a reasonable amount of airvoid which will allow it to withstand the stresses pertaining to the free-thaw cycles. The PCI manual requires a minimum of one daily test for each mix design or when the strength cylinders are being made. In addition to the mentioned requirements it is recommended to perform the air content test in the first load of concrete pouring for each element and if the first load does not meet the specifications then keep on doing the test on each consecutive load until the mix design requirement is met.

The concrete unit weight and air content test should be performed according to ASTM C138 standard or AASHTO T121.

4.2.2.1.f. Slump/Spread

The slump/spread test is required to measure the concrete consistency and workability during the manufacturing process. This test is also a good indicator to figure out if the correct amount of water is in the mix. The required test standard is the ASTM C143 or AASHTO T119. Each mix design should have a definite slump number and test should be done at start of operations (first load), when making strength specimens, when the consistency of the concrete appears to vary (if consecutive tests are off by 0.5 inch, each load should be tested until consistent results are noticed), and at least once per every three air content tests.

4.2.2.1.g Temperature

The fresh concrete temperature affects the hydration reaction speed and if not given proper attention can result in significant premature damages to concrete in curing process. The temperature test should be performed during the slump and air tests or when the strength cylinders are made. The standard test specification for concrete temperature measurement is ASTM C1064 or AASHTO T309.

4.2.2.1.h J-Ring

J-Ring test is a measure of ability of concrete to pass through the reinforcing bars and pre-stressing strands. This test is required specifically when the concrete is SCC (Self Consolidating Concrete). The slump flow test is designed to make sure the concrete is able to fill the formwork where J-Ring is a measure of how the concrete is able to flow through very tight spaces without segregation. Actually, the difference between the J-Ring and slump indicates the passing ability of SCC concrete. If the difference between the measurements from slump and J-Ring is less than one inch the passing ability is considered to be good but a difference of more than two inches indicates a poor passing ability. The frequency of this test should be considered the same as slump/spread test. The standard test method is the ASTM C1621 or AASHTO T345.

4.2.2.1.i Chemical Admixtures

These are the additives that can be used for different purposes like lowering the water/cement ratio and increasing and decreasing the hydration reaction time in concrete. Some of the most frequent chemical additives are superplasticizers, retarders, accelerators and air entraining agents. If these additives are to be used in the concrete mix they should be provided from the qualified product producer list. If the mill report is provided no other test is required.

Table 43 - Pre-Stressed Concrete Material and Constituents QC Tests and Requirements

Pre-stressed Concrete material and required tests	PCI Requirements	Additions to PCI/Explanations
Cementitious Materials	If mill certificates are not provided, testing should be performed on each shipment.	None.
Water	None.	at least once per year or whenever the source of water changes
Pre-stressing Strands	the product should be tested in accordance with ASTM A370 standard	2 meter sample per heat number of seven wire pre-stressing strands should be tested in accordance with the ASTM A416 standard
Unit Weight	Minimum of once per week	None.
Air Content	Minimum of one daily check per mix design or when making strength cylinders	Minimum of first load, once per element, and if first load does not meet specification then each consecutive load until uniform results are observed
Slump/Spread	At start of operations (first load), when making strength specimens, when the consistency of the concrete appears to vary, and at least once per every 3 air content tests	Consistency varies if consecutive tests are off by 0.5 inch and each load should be tested until consistent results are noticed
Temperature	When slump, air, or strength cylinders are made	None.
J-Ring	None	At start of operations (first load), when making strength specimens, when the consistency of the concrete appears to vary, and at least once per every 3 air content tests.
Chemical Admixture	None	Provide mill reports and supplied by member of qualified product producer

4.2.2.1.j Concrete Strength Cylinders

The strength cylinders should be cast and tested in accordance with ASTM C39 or AASHTO T22 standard. The following table details the recommended number of compression test cylinders and the frequency PCI MNL-116 along with the additional requirements to the QSM that are recommended by the researchers.

Table 44 - Pre-stressed Compression Cylinders QC Requirements

Compression Cylinders	PCI Requirements	Additions to PCI/Explanations
Minimum Number to be cast	Four	Additional 4 cylinders for destressing (total of 8 cylinders)
Frequency of Casting	Daily for each individual concrete mix or every 75 CY of a given mix design	Minimum of once per element

4.2.2.1.k Casting Bed

Prior to start of any concrete pouring procedure the casting bed plan should be submitted to QA inspector. This is probably of utmost importance for a high quality product since the casting bed directly affects the final profile and alignment of the pre-stressed elements.

4.3 Structural Precast Elements and Non-Structural Precast Elements:

The following section details the recommendations for Producer Qualification (Plant Inspection), Quality Control procedures, and Quality Assurance procedures for Structural Precast Elements and Non-Structural Precast elements. The two precast elements categories can be combined as many of the recommended processes are the same. In cases where the processes vary from one another, the type of element in which the information relates to will be explicitly stated.

4.3.1 Plant Certification Requirements

The recommendations for producer qualification are either PCI or NPCA certification followed by an Agency audit of the fabricator to ensure that all of the requirements are met. The information collected throughout the research showed that the New England agencies were fairly split between requiring NPCA or PCI for Plant Certification. From these findings, it is recommended that either is sufficient, however, the QSM should be chosen prior to Plant Inspection. This means that the agency must determine whether it is required to be PCI, NPCA, or both prior to plant inspection. In addition to above, the inspector office and facility requirements by Rhode Island DOT are the most comprehensive. They should be adopted as a standard in the unified specification with the addition of office sharing amongst the agencies.

It is recommended that Structural Precast Elements choose between PCI or NPCA for plant inspection. Non-Structural Precast Plant Certification is recommended to follow NPCA requirements. The following section will present the requirements put forth by both PCI and NPCA. As previously mentioned, the QSM should be selected prior to plant inspection for Structural Precast Elements. The recommended QSM for Non-Structural Precast Elements is NPCA. Plant requirements for structural and non-structural precast elements are provided in Table 45.

Table 45 - Precast Plant Certification Recommendations

Plant Inspection	NPCA or PCI Requirements		Additional to the requirements
Choose QSM Below			-
Certification	PCI	NPCA	-
QC Qualification	PCI Level 2	ACI Level 2 or PCI Level 1 or future NETTCP PS Level 1	a PCI level 1 with at least three years of experience under intermittent supervision of a level 2
PCI Groups	B1, C1	-	-
Office Requirements	RI DOT with office sharing	RI DOT with office sharing and internet	-
QSM	PCI MNL-116	NPCA	PCI MNL-137 for concrete repair purposes
Miscellaneous	-	-	Providing Safety plan and letting 5% of cement storage silos be empty for expansion

4.3.2 Plant Sampling and Testing Requirements

The Quality Control procedures were developed using PCI MNL-116 requirements and NPCA with additional variations that are recommended by the researchers. The procedures that are included are plastic concrete testing frequencies, cylinders for strength and destressing testing, aggregate sampling and testing, cementitious materials, and reinforcing bars.

Structural Precast Elements are recommended to follow either PCI MNL-116 or NPCA with the additional requirements. Non-Structural Precast Elements are recommended to follow NPCA procedures with the additional requirements. The following table describes the plastic concrete testing frequencies for QC purposes as provided by PCI MNL-116 and NPCA with the recommended additions. Table 46 summarizes the plant QC testing requirements for these elements.

Table 46 - Structural and Non-Structural Precast Concrete Elements QC Requirements

Pre-stressed Concrete material and required tests	PCI Requirements	NPCA Requirements	Additions to PCI/Explanations
Cementitious Materials	If mill certificates are not provided, testing should be performed on each shipment.	Mill reports should be provided with each shipment	None.
water	None.	None.	at least once per year or whenever the source of water changes
Reinforcing bars	Testing is not required if mill reports are provided. If mill reports are not provided, it should be tested in accordance with ASTM A370	Mill reports should be provided with each shipment	ASTM A706/A 706-M09 or ASTM A615/A 615-M09 depending on the type of rebar being used
Unit Weight	Minimum of once per week	150 CY of concrete or once per day	each time the mixture design changes or its constituents change
Air Content	Minimum of one daily check per mix design or when making strength cylinders	150 CY of concrete or once per day	Minimum of first load, once per element, and if first load does not meet specification then each consecutive load until uniform results are observed

Slump/Spread	At start of operations (first load), when making strength specimens, when the consistency of the concrete appears to vary, and at least once per every 3 air content tests	150 CY of concrete or once per day	Consistency varies if consecutive tests are off by 0.5 inch and each load should be tested until consistent results are noticed
Temperature	When slump, air, or strength cylinders are made	When slump, air, or strength cylinders are made	None.
J-Ring	None	None	At start of operations (first load), when making strength specimens, when the consistency of the concrete appears to vary, and at least once per every 3 air content tests
Chemical Admixture	None	None	Provide mill reports and supplied by member of qualified product producer

Table 47 details the recommended number of compression test cylinders and the frequency that they should be cast. Similar to the previous tables, the information is presented by showing the requirements put forth by PCI MNL-116 and NPCA along with the additional requirements to the QSM that are recommended by the researchers.

Table 47 - Precast - Compression Cylinders QC Recommendations

Compression Cylinders	PCI Requirements	NPCA Requirements	Additions to PCI/Explanations
Minimum Number to be cast	Four	Four	Additional 4 cylinders for destressing (total of 8 cylinders)
Frequency of Casting	Daily for each individual concrete mix or every 75 CY of a given mix design	Every 150 CY of concrete for each mix or once per week, whichever comes first	Minimum of once per element

The sampling and testing of coarse and fine aggregates are provided in PCI MNL-116 and NPCA. At this time, these requirements are sufficient to ensure the quality and gradation are meeting the specification requirements or the mix design that was approved by the state agency. The frequencies of sampling and testing provided by each manual are tabulated below.

Table 48 - Precast - Aggregate Testing QC Recommendations

Aggregates	PCI Requirements	NPCA Requirements
Coarse	Every 1,000 tons	Every 2,000 tons
Fine	Every 500 tons	Every 1,500 tons

The sampling and testing of cementitious materials and pre-stressing strands are not included in PCI MNL-116 or NPCA. However, in both manuals, it is stated that the testing is not required if the mill reports for each material are provided to the fabricator. If mill reports are not provided by the supplier, then appropriate testing must take place to ensure the quality of the materials that are being used. The following table describes the recommended requirements from each manual.

Table 49 - Precast - Constituent Materials QC Recommendations

	PCI Requirements	NPCA Requirements
Cementitious Materials	If mill certificates are not provided, testing should be performed on each shipment.	Mill reports should be provided with each shipment
Reinforcement bars	Testing is not required if mill reports are provided. If mill reports are not provided, the pre-stressing strands should be tested in accordance with ASTM A370.	Mill reports should be provided with each shipment

4.4 Summary

This chapter presents the plant certification and producer testing requirements for the manufacturers of the different types of precast elements. The important points that were discussed in this chapter are as follows:

- Certification Manuals:
  - PCI and NPCA
    - These are the two broad types of certifications that the manufacturers can obtain depending on the type of the element that they produce.
    - The main focus of PCI is the pre-stressed concrete elements while NPCA issues the certifications for the producers of structural and non-structural elements.
- Pre-stressed elements:
  - Plant certification manual
    - PCI-MNL-116 is the specific manual for producing the pre-stressed elements where the PCI-MNL-137 is used for the purpose of repair of problematic elements.
  - QC personnel qualifications
    - In accordance to PCI manual the QC personnel should have a level 2 certificate as a minimum requirement. This study also recommends the use of level 1 with 4 years of experience under the intermittent supervision of a level2.
  - Office requirements
    - The inspector office and facilities provided by Rhode Island DOT are the most comprehensive and the only extra requirements are the internet connection and a meeting table.
  - Safety
    - It is strongly advised that the manufacturer gets use of at least one subject matter expert Health, Safety and Environment (HSE) personnel with related safety certificate to design a safety plan and have the other personnel trained for emergency conditions.

- Plant sampling and testing requirements
  - Aggregate
    - According to PCI requirements coarse aggregate should be tested every 1000 tons and the fine aggregate should be tested every 500 tons. This study recommends a testing frequency of at least once a week in addition to PCI requirements.
  - Cementitious materials
    - If mill certificates are not available, testing should be performed on each shipment.
  - Pre-stressing strands
    - In addition to PCI requirements, a 2 meters sample per heat number should be tested in accordance to the ASTM A416 standard.
  - J-Ring test
    - This test should be performed to evaluate the flowability of concrete In addition to slump/spread test.
  - Compression Cylinders
    - In addition to PCI requirements, there should be an additional 4 cylinders casted for destressing.

- Structural precast and Non-Structural precast elements:
  - Plant certification manual
    - The information collected throughout the research showed that the New England agencies were fairly split between requiring NPCA or PCI for Plant certification. From these findings, it is recommended that either is sufficient, however, the QSM should be chosen prior to Plant Inspection.
  - QC personnel qualifications
    - The PCI recommends that QC personnel should have a level 2 certificate while the NPCA requires an ACI level 2 or PCI level 1 or future NETTCP PS level 1. This research also recommends a PCI level 1 with at least three years of experience under intermittent supervision of a level 2.
  - Plant sampling and testing requirements
    - Structural precast elements,
      - In addition to PCI and NPCA requirements the reinforcing bars should be tested in accordance to the ASTM A706/A 706-M09 or ASTM A615/A 615-M09 depending on the type of rebar being used.
    - Non-structural precast elements
      - Testing is not required if mill reports are provided. If mill reports are not provided, the pre-stressing strands should be tested in accordance with ASTM A370.

5. Agency Quality Assurance Inspection Requirements

5.1 Concrete Pouring Procedure Inspection

As previously discussed in chapter two of this report the three different stages of concrete production procedure are the pre-pour, during pour and post pour.

The pre-pour process includes the inspection of calibration of equipment, pre-stressing strands for pre-stressed elements, reinforcing bars for structural and non-structural elements and the frames that are being used during the concrete production while the during pour inspection process contains the tests and sampling frequency of fresh concrete mix. The hardened concrete is then inspected in post pour process which reassures that the final dimensions and the quality of the product is compatible to the drawings.

The following section describes the various aspects that are recommended to be included in the inspection process. The QA inspection process includes the witnessing of QC procedures and documenting the results as well as performing agency testing to ensure the QC results are accurate and acceptable.

The recommendations were developed through the use of current inspection checklists from the various agencies as well as the quality control sampling and testing frequencies. Quality assurance testing must be performed on a random basis, however, the minimum frequencies of the various tests should be specified to ensure the testing is performed on a basis that allows for the acceptance of the QC results.

5.2 Pre-stressed Elements

5.2.1 Pre-Pour

The pre-pour inspection is performed in three steps. The first step of the pre-pour inspection process involves checking the calibration of the equipment that is being used during the production process. Table 50 shows the various equipment that should be calibrated and the information required to be documented for the Pre-Stressed concrete elements. It is also very important to note that prior to start of pouring the concrete, there should be a defined concrete placement sequence plan for any type of precast concrete element which significantly reduces the risk of creation of any horizontal or cold joints in the product.

Table 50 - Equipment Calibration Recommendations for Pre-Stressed Concrete Elements

Pre-Pour Inspection	Required Information	Remarks
Calibrations		
Aggregate conveyor	Visual check	Once every week
Cement Scales	Date of Last Calibration	Every 6 months or per 60000m^3 concrete production whichever comes first
Aggregate Scales	Date of Last Calibration	
Water Meter	Date of Last Calibration	
Air meter	Date of Last Calibration	Every three months during use
Stressing Jack and Gauges	Date of Last Calibration	Once per year or in case of any erratic result
Cylinder Compression Tester	Date of Last Calibration	Once per year or in case of any erratic result (1.0% discrepancy of verified loading range)

The second step of the pre-pour inspection includes the inspection of the pre-stressing strands to be used in the element. This procedure is also completed throughout pre-pour inspection. The parameters that are required to be inspected and documented are shown in the table below.

Table 51 - Pre-stressing Strand Inspection Recommendations

Pre-Pour Inspection	Required Information
Pre-stressing Strand	
Domestic Origin	Yes or No
Coil Identification	ID Number
Cross Sectional Area	Cross Section (square inches)
Modulus of Elasticity	Check QC Technician's provided data and document
Stressing Calculations	Check QC Technician's provided data and document
Size (diameter)	Strand Diameter
Strand Pattern in Form	Copy of the strand pattern
Lateral Location	Check QC Technician's provided data and document
Vertical Location	Check QC Technician's provided data and document
Clean of Contaminants	Yes or No
Elongations	Check QC Technician's provided data and document
Strands Temperature	Should be 70°F otherwise temperature correction factors should be used to determine the proper tensioning length
Strands Pattern	Strands are set up according to the design plan (hold down- hold up locations)

The third aspect of pre-pour inspection that is recommended includes the form inspection for the particular element. The parameters that should be inspected and documented are shown in the table below.

Table 52 - Pre-stressed- Form Inspection Recommendation

Pre-Pour Inspection	Required Information
Form Inspection	
Length	Confirm Length and document
Width	Confirm Width and document
Height	Confirm Height and document
Shearkey Dimensions	Inspect with QC Tech and document
Chamfers	Inspect with QC Tech and document
Dowel Pin Tube Locations	Inspect with QC Tech and document
Post Tensioning Duct Size/Locations	Inspect with QC Tech and document
Post Tensioning Duct Blockout Size (Fascia Beams)	Inspect with QC Tech and document
Excess Form Oil to be Dry Mopped	Yes or No
Form Ties and Inserts Recessed	Document (minimum of 1 inch)
Void Dimensions	Dimensions (inches)
Void Location – Lateral, Vertical, and End	Location of the voids
Void Location After Concrete Placement – Witness QC Checking Location after Hold Downs Removed	Inspect with QC Tech and document

5.2.2 During-Pour

The following table describes the QA procedures that are recommended to be completed throughout the pour of the pre-stressed elements. The testing methods are the same as the QC procedures, however, QA testing will be less frequent than QC as it is intended to simply verify the results that were obtained throughout the QC testing. QA sampling and testing is also completed on a random basis and the frequencies that are supplied in the following table are the minimum recommendations.

These procedures include the sampling and testing of the concrete mix as opposed to the previous section (pre-pour inspection) that included the witnessing of QC procedure and documenting the results. The during-pour inspection process requires the sampling and testing to be performed by the QA inspector.

Table 53 - Pre-stressed - During Pour Inspection Recommendations

During-Pour Inspection	Recommendations
Air Content	Frequency: At least once per element and every 100 CY
Slump (Spread)	Frequency: At least once per element and every 100 CY
J-ring	Frequency: At least once per element and every 100 CY
Temperature	Frequency: At least once per element and every 100 CY
Water/Cement Ratio	Frequency: At least once per element and every 100 CY
Lifting embedment	Placed at the proper location according to DWGs
Compression Cylinder Fabrication	Frequency: At least once per element and every 100 CY Number of Cylinders: 6 for strength and permeability testing.
Cylinders for Stripping Strength	Frequency: At least once per element Number: 2 cylinders for stripping strength

Note: Curing of the samples should be consistent to the final curing method used for elements.

5.2.3 Post-Pour

The final aspect of inspection for precast elements included in this report are the post-pour inspection requirements. Similar to the pre-pour inspection, these parameters should be inspected in conjunction with the QC technician and the observations should be documented. The post-pour inspection checklist and required information is shown in the table below.

Table 54 - Pre-stressed - Post Pour Inspection Recommendations

Post-Pour Inspection	Required Information
Length	Document Length (feet)
Width	Document Width (feet)
Height	Document Height (feet)
Sweep	Inspect with QC Tech and document
Camber	Inspect with QC Tech and document
Surface Finish	Yes or No and type of finish
Interior Beam Finish	Yes or No and type of finish
Top Finish	Yes or No and type of finish
Void Drains Opened	Yes or No
Cold Joints/Laminations	Yes or No
Cracks/Chips/Spalls	Yes or No and NCR if necessary
Concrete Cleaned from Exposed Reinforcing	Yes or No
Chamfer Smoothness/Uniformity	Inspect with QC Tech and document
Post-Tensioning Duct Locations	Inspect with QC Tech and document
Unit Identification	ID Number of element
Destressing Strength Testing	Witness Strength tests and document
Destressing	Witness destressing of element

Curing of the element is a portion of the post-pour inspection process. For PSE, accelerated curing is recommended to be allowed and should be controlled by the processes put forth by PCI MNL-116. The requirements as stated by PCI MNL-116 are shown in the table below.

Table 55 - Pre-Stressed - Curing Recommendations

Post-Pour Inspection	Recommendations (PCI MNL-116)
Curing	The concrete in the form shall be maintained at a temperature of not less than 50˚F during the curing period (prior to stripping strength)
	Accelerated Curing – The controlling temperatures shall be those actually achieved within the concrete elements.
	Accelerated curing shall be started after the concrete has attained initial set. (ASTM C403, *Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance*).
	The concrete temperature may be increased during the preset period at a rate not to exceed 10˚F per hour. The total permissible temperature gain during the preset period shall not exceed 40˚F higher than the placement temperature or 104˚F, whichever is less.
	A heat gain not to exceed 36˚F per hour, measured in the concrete, is acceptable provided the concrete has attained initial set.
	The maximum curing temperature shall not exceed 180˚F.

Note: The method of curing should be defined prior to start of any concrete placement. The different methods include but are not limited to water curing, chemical membrane curing and heat (steam) curing. If the accelerated heat (steam) curing is used, concrete should be maintained in warm and moist conditions while releasing the strands. This eliminates the risk of creation of any tensile stress due to contraction of concrete after the heat curing while the strands are still in tension.

In addition to the post-pour checklist shown above, it is also recommended to perform permeability testing on the compression strength cylinders. The testing method should follow AASHTO T-358 "Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration" and is recommended to be performed on a minimum of two cylinders that were fabricated for compression strength or destressing strength.

5.3 Structural Precast and Non-Structural Precast Elements

The following sections detail the recommendations for Quality Assurance requirements and testing frequency for Structural Precast Elements and Non-Structural Precast elements. The two precast elements categories can be combined as many of the recommended processes are the same. In cases where the processes vary from one another, the type of element in which the information relates to will be explicitly stated.

5.3.1 Pre-Pour

The same as the pre-stressed elements the pre-pour inspection process for the structural and non-structural elements is done in three steps.

Table 56 details the first step of the pre-pour inspection process which involves checking the calibration of the equipment that is being used. The recommended pre-pour QA processes for Structural Precast Elements and Non-Structural Precast Element are the same. The table shows the various equipment that should be calibrated and the information required to be documented. It is critical to define a concrete placement sequence plan prior to start of production to prevent any probable horizontal and cold joints in the precast concrete elements.

Table 56 -- Precast - Pre Pour Inspection Recommendations

Pre-Pour Inspection	Required Information	Remarks
Calibrations		
Aggregate conveyor	Visual check	Once every week
Cement Scales	Date of Last Calibration	Every 6 months or per 60000m^3 concrete production which comes first
Aggregate Scales	Date of Last Calibration	
Water Meter	Date of Last Calibration	
Air meter	Date of Last Calibration	Every three months during use
Cylinder Compression Tester	Date of Last Calibration	Once per year or in case of any erratic result (1.0% discrepancy of verified loading range)

The second step of the pre-pour inspection includes the inspection of the reinforcing steel that is to be used in the elements. The inspection of the reinforcing steel takes place prior to pouring of the element which makes it a part of pre-pour inspection. The parameters that are required to be inspected and documented are shown in Table 57.

Table 57 - Precast - Reinforcing Steel Inspection Recommendations

Pre-Pour Inspection	Required Information
Reinforcing Steel	
Domestic Origin	Yes or No
Confirm Manufacturer	Manufacturer Name
Bar Size	Bar Size
Bar Dimensions	Dimensions
Bar Location in Form	Bar Locations
Projection Above Form	Bar Projections
Bar Quantities	Number of Bars
Clearance	Clearance
Dielectric Chairs (epoxy coated steel)	Yes or No
Certificate of Compliance for Epoxy Coating	Provided by QC Technician (One sample per size, per year, per manufacturer)
Splice Lap Lengths	Length of Splice Laps
Coated Tie Wire (epoxy)	Yes or No
Clean of Contaminants	Yes or No

The third aspect of pre-pour inspection that is recommended includes the form inspection for the particular element. The parameters that should be inspected and documented are shown in Table 58.

Table 58 - Precast - Form Inspection Recommendations

Pre-Pour Inspection	Required Information
Form Inspection	
Length	Confirm Length and document
Width	Confirm Width and document
Height	Confirm Height and document
Shearkey Dimensions	Inspect with QC Tech and document
Chamfers	Inspect with QC Tech and document
Dowel Pin Tube Locations	Inspect with QC Tech and document
Post Tensioning Duct Size/Locations	Inspect with QC Tech and document
Post Tensioning Duct Blockout Size (Fascia Beams)	Inspect with QC Tech and document
Excess Form Oil to be Dry Mopped	Yes or No
Form Ties and Inserts Recessed	Document (minimum of 1 inch)
Void Dimensions	Dimensions (inches)
Void Location – Lateral, Vertical, and End	Location of the voids
Void Location After Concrete Placement – Witness QC Checking Location after Hold Downs Removed	Inspect with QC Tech and document

5.3.2 During-Pour

The following table describes the QA procedures that are recommended to be completed throughout the pour of the precast elements. The testing methods are the same as the QC procedures, however, QA testing will be less frequent than QC as it is intended to simply verify the results that were obtained throughout the QC testing. QA sampling and testing is also completed on a random basis and the frequencies that are supplied in the following table are the minimum recommendations.

These procedures include the sampling and testing of the concrete mix as opposed to the previous section (pre-pour inspection) that included the witnessing of QC procedure and documenting the results. The during-pour inspection process requires the sampling and testing to be performed by the QA inspector. Table 59 describes the recommendations for Structural Precast Elements sampling and testing frequencies. The recommended sampling and testing frequencies for purposes of QA of Non-Structural Precast Elements is shown in Table 60.

Table 59 - Structural Precast - During Pour Inspection Recommendations

During-Pour Inspection	Recommendations
Air Content	Frequency: At least once per element and every 100 CY
Slump (Spread)	Frequency: At least once per element and every 100 CY
J-Ring	Frequency: At least once per element and every 100 CY
Temperature	Frequency: At least once per element and every 100 CY
Water/Cement Ratio	Frequency: At least once per element and every 100 CY
Compression Cylinder Fabrication	Frequency: At least once per element and every 100 CY Number of Cylinders: 6 for strength and permeability testing.
Cylinders for Stripping Strength	Frequency: At least once per element Number: 2 cylinders for stripping strength

Note: Curing of the cylinders should take place in the same conditions as the element itself.

Table 60 - Non Structural Precast - During Pour Inspection Recommendations

During-Pour Inspection	Recommendations
Air Content	Frequency: Once per continuous pour
Slump (Spread)	Frequency: Once per continuous pour
Temperature	Frequency: Once per continuous pour
Water/Cement Ratio	Frequency: Once per continuous pour
Compression Cylinder Fabrication	Frequency: Frequency: Once per continuous pour Number of Cylinders: 6 for strength testing
Cylinders for Stripping Strength	None

Note: Continuous pour is described as the placement of same types of elements using the same mix on a given day.

Note: Curing of the samples should be consistent to the final curing method used for elements.

5.3.3 Post-Pour

The final aspect of inspection included in this report are the post-pour inspection requirements. Similar to the pre-pour inspection, these parameters should be inspected in conjunction with the QC technician and the observations should be documented. The post-pour inspection checklist and required information is shown below in Table 61. This checklist applies to both Structural Precast Elements and Non-Structural Precast Elements.

Table 61 - Precast - Post Pour Inspection Recommendations

Post-Pour Inspection	Required Information
Length	Document Length (feet)
Width	Document Width (feet)
Height	Document Height (feet)
Sweep	Inspect with QC Tech and document
Camber	Inspect with QC Tech and document
Surface Finish	Yes or No and type of finish
Interior Beam Finish	Yes or No and type of finish
Top Finish	Yes or No and type of finish
Void Drains Opened	Yes or No
Cold Joints/Laminations	Yes or No
Cracks/Chips/Spalls	Yes or No and NCR if necessary
Concrete Cleaned from Exposed Reinforcing	Yes or No
Chamfer Smoothness/Uniformity	Inspect with QC Tech and document
Post-Tensioning Duct Locations	Inspect with QC Tech and document
Unit Identification	ID Number of element

Curing of the element is a portion of the post-pour inspection process. For Structural Precast Elements, accelerated curing is recommended to be allowed and should be controlled by the processes put forth by PCI MNL-116. The requirements as stated by PCI MNL-116 are shown in Table 62.

Table 62 - Structural Precast - Curing Recommendations

Post-Pour Inspection	Recommendations (PCI MNL-116)
Curing	The concrete in the form shall be maintained at a temperature of not less than 50˚F during the curing period (prior to stripping strength)
	Accelerated Curing – The controlling temperatures shall be those actually achieved within the concrete elements.
	Accelerated curing shall be started after the concrete has attained initial set. (ASTM C403, *Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance*).
	The concrete temperature may be increased during the preset period at a rate not to exceed 10˚F per hour. The total permissible temperature gain during the preset period shall not exceed 40˚F higher than the placement temperature or 104˚F, whichever is less.
	A heat gain not to exceed 36˚F per hour, measured in the concrete, is acceptable provided the concrete has attained initial set.
	The maximum curing temperature shall not exceed 180˚F.

In addition to the post-pour checklist shown above, it is also recommended to perform permeability testing on the compression strength cylinders for Structural Precast Elements only. The testing method should follow AASHTO T-358 "Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration" and is recommended to be performed on a minimum of two cylinders that were fabricated for compression strength or stripping strength.

5.4 Summary

This chapter presents the agency quality assurance inspection and testing requirements to provide a unified inspection procedure for New England state DOTs. The important points that were discussed in this chapter are as follows:

- Concrete inspection stages :
    - Pre-pour, during pour and post-pour
        - The pre-pour process includes the inspection of calibration of equipment, pre-stressing strands for pre-stressed elements, reinforcing bars for structural and non-structural elements and the frames that are being used during the concrete production while the during pour inspection process contains the tests and sampling frequency of fresh concrete mix. The hardened concrete is then inspected in post pour process which reassures that the final dimensions and the quality of the product is compatible to the drawings.
            - Prior to start of pouring the concrete, there should be a defined concrete placement sequence plan for any type of precast concrete element which significantly reduces the risk of creation of any horizontal or cold joints in the product.
            - For the during pour stage, The testing methods are the same as the QC procedures, however, QA testing will be less frequent than QC as it is intended to simply verify the results that were obtained throughout the QC testing.
            - The hardened concrete should be inspected in conjunction with the QC technician and the observations should be documented.
            - Accelerated curing is recommended to be performed for the PSE/PCE products and should be controlled by the processes put forth by PCI MNL-116.
            - For PSE elements if the accelerated heat (steam) curing is used, concrete should be maintained in warm and moist conditions while releasing the strands to eliminates the risk of creation of any tensile stress due to contraction of concrete after the heat curing while the strands are still in tension.
            - For all of the prefabricated elements, Curing of the strength cylinders should be consistent to the final curing method used for elements.
            - In addition to the post-pour checklist, it is also recommended to perform permeability testing on the compression strength cylinders. The testing method should follow AASHTO T-358 “Surface Resistivity Indication of Concrete’s Ability to Resist Chloride Ion Penetration” and is recommended to be performed on a minimum of two cylinders that were fabricated for compression strength or destressing strength.

6. Summary and Conclusions:

As part of this review, a review of QA practices was conducted for precast and pre-stressed concrete elements (PCE and PSE) used in highway construction. The research activities included review of published literature and an in-depth evaluation of current acceptance and compliance conformance processes of New England state transportation agencies for PCE and PSE. The evaluation was conducted through review of: state specifications, quality assurance manuals, checklists, and sample inspection reports; as well as through interview of QA personnel and visits to two fabrication facilities while elements were being produced for New England states. A highlight of the review findings is presented next.

6.1 Highlights of Review Findings

- A large number of fabricators were found to be supplying elements to multiple New England states, this is true for both PCE and PSE. For example, there are 8 fabricators in the New England region that have recently supplied PSE or PCE to Connecticut, Massachusetts, Maine, and Rhode Island.
- The producer qualification requirements for PSE fabrication is found to be very similar between various New England states. All of them allow use of PCI certification as a qualification standard. Several agencies (such as, Massachusetts and Vermont) also conduct audit of the facility to ensure that all requirements are met. Massachusetts and Vermont also allows PCI certified facilities to produce non-prestressed elements (PCE). In general, most states allow use of NPCA certification as baseline for fabrication of non-structural precast elements. For agencies that do not explicitly require PCI or NPCA certification for PCE, the agencies indicated during interviews that most of their fabricators are NPCA certified or meet the requirements put forth by NPCA.
- The agencies are comparable in their fabricator QC requirements (testing, facilities, QC technician qualification and quality control manual/quality service manual). For PSE producers, the PCI MNL-116 requirements are accepted. As for PCE, most states required the plant QSM to follow NPCA. Due to the requirements of the QSM, the technician certification followed the specification put forth by either PCI MNL-116 or NPCA.
- There is a full spectrum of QA inspector types in New England in terms of agency employee versus consultant QA inspector usage. Connecticut, Maine, and Vermont use both consultant and in-house QA inspectors. Rhode Island explicitly uses in-house inspectors. Massachusetts and New Hampshire use only consultant inspectors. On basis of the current consultant inspection contracts, the range of cost per hour per inspector is found to be from \$50 to \$100. The lower range does not include travel reimbursement which is paid separately.
- The pre-pour inspection processes amongst the states were found to be comparable. Each agencies process includes a pre-pour checklist with attributes that are very similar between

agencies. As expected, the pre-pour inspection is substantially more stringent for prestressed and structural precast elements.

- The plastic testing was similar amongst the states as they all require the necessary tests to ensure the quality of the mix. However, the frequencies of these tests were found to vary significantly amongst the state agencies. It was found that the frequency of testing ranged from testing per sub-lot (typically defined as one element) to a consistency based sampling frequency. The consistency based frequency method included the testing of the first two batches and if both batches pass all of the requirements as well as have same results, then a lower frequency is used for subsequent sampling.
- The majority of the states require inspectors to be present for the destressing of prestressed elements with exception of Connecticut. Regarding stripping of forms and assessment of stripping and/or destressing strength, the requirements vary between states as to whether inspector is to witness the strength tests or not.
- The requirements between states are not similar in the number of compressive strength cylinders that were required to be cast and tested. Also, all states conduct 28 day strength testing, but some require additional testing, such as 56 day strength measurements by Massachusetts. Furthermore, only two states currently have requirements in place to determine durability of concrete in terms of permeability through surface resistivity testing (Maine and New Hampshire).
- The post-pour inspection processes were found to be also very similar amongst the states. Once again, post-pour inspection checklists are available from each state for use by QA inspectors. The procedure for resolving non-conformance is also similar between states, where producers provide a repair plan (typically PCI recommendations for PSE and PCI or NPCA recommendations for structural PCE and NPCA recommendations for non-structural PCE) that is approved by design engineer. The repairs are inspected by QA inspectors before providing certificate of compliance.
- Majority of agencies require QA inspectors to witness loading of elements on to transportation vehicle before approval seal is applied or certificate of compliance is issued. Although exceptions to this requirement have been allowed due to logistical reasons where elements are stored at fabrication facility for a duration before shipping to construction site.
- The frequency of aggregate, cementitious materials, and steel sampling testing vary substantially between the agencies. Majority of agencies follow the requirements put forth in structural concrete specifications for sampling and testing of constituent materials. Between six New England agencies, frequency of sampling cementitious materials vary from annual to sample taken at every 150 CY of concrete production. Samples of strands and reinforcing bars were found to be taken primarily by following random number sheets and are once again governed through material specifications and QA plan.
- All agencies allow accelerated curing of precast elements. Majority of agencies do not specify controls associated with curing conditions, internal temperature etc. (Maine being only exception). In some cases, the inspection of curing processes is not included in the current

acceptance process (such as, Connecticut). For PSE, agencies require the curing processes to follow the guidelines provided by PCI. Maine DOT has the most mature specifications for curing requirements, the specifications follow PCI guidelines with few additions.

- The concrete mix design approval process is similar amongst the states. The fabricators would provide mix designs that would be approved by each individual state agency. The requirements for mixes do vary between states. Several requirements have small variations (such as minimum air content to be 8.5% versus 9%), however these lead to requiring several mixes for producers to be able to manufacture, many times on a single day. If similar requirements are agreed upon by agencies, it will streamline mix acceptance and control processes as well as potentially lower the cost. Use of performance based specifications for concrete might aid in use of same concrete for multiple agencies products.
- A few currently utilized practices as well as some that are currently under implementation at various DOTs could really aid in implementation of the unified QA process between New England DOTs. For example, use of RFID (Radio Frequency Identity) tag with cloud based data-storage system that is being evaluated by MassDOT could serve as a vehicle for management of information and the use of “Shift Planning” system used by VTrans can make it streamlined to keep database of eligible inspection personnel in the region, their availability as well as tracking of their work hours.

6.2 Summary of Recommendations:

On the basis of the review findings recommendations are made regarding unification of QA processes between New England state transportation agencies. The recommendations are broadly divided into major categories associated with the QA process. These overall categories of the QC process are Producer Qualification, Quality Control and Quality Service Manual, and Quality Assurance Inspection. Furthermore, the recommendations are provided for Pre-stressed Elements, Structural Precast Elements, and Non-Structural Precast Elements.

- Producer Qualification (Plant Certification):
  - PCI Certification for PSE and structural PCE fabricators followed by an agency audit to ensure that all requirements are met.
  - For non-structural precast elements, NPCA certification of facilities with agency audit is widely accepted and deemed appropriate.
  - The inspector office and facility requirements by Rhode Island DOT are most comprehensive. They should be adopted as a standard in the unified specifications.

- Quality Control and Quality Service Manual
  - Requirements entailed in PCI MNL-116 should be used for PSE and structural PCE, this is currently adopted by all states.

    - In situations that there is a need to repair precast elements (both PSE and PCE) the guidelines of PCI-MNL-137 which is specifically designed in this regards should be followed.
    - For non-structural PCE, either use of requirements in PCI MNL-116 or those required as part of plant certification by NPCA should be adopted. Three agencies (MA, ME and VT) already require these and others procure elements predominantly from fabricators that are NPCA certified.
    - QC Technician Qualification:
        - PSE: Minimum of PCI level 2 or higher qualification or future NETTCP PS level 1 certification that is currently under finalization. This study also recommends to deploy a PCI level one with 4years of subject experience under intermittent supervision of a level2.
        - PCE: Minimum ACI level 2 or PCI level 1 or future NETTCP PS level 1 certification. ACI level 1 is also acceptable for non-structural PCE. This study also recommends to deploy a PCI level 1 with at least three years of experience under intermittent supervision of a level 2.
- Plant sampling and testing requirements
    - Pre-pour level
        - Cementitious material: If mill certificates are not provided, testing should be performed on each shipment.
        - Water: Should be tested at least once per year or whenever the source of water changes.
        - Pre-stressing strands for PSE: In addition to PCI requirements, 2 meter sample per heat number of seven wire pre-stressing strands should be tested in accordance with the ASTM A416 standard.
        - Reinforcing bar for PCE: In addition to PCI and NPCA requirements, the product should be tested in accordance to the ASTM A706/A 706-M09 or ASTM A615/A615 M 09 depending on the type of rebar being used.
        - J- Ring test: If the concrete used to cast the elements is Self-Consolidating Concrete (SCC) this test should be done at start of operations (first load), when making strength specimens, when the consistency of the concrete appears to vary, and at least once per every 3 air content tests.
        - Casting bed: Prior to start of any concrete pouring procedure the casting bed plan should be submitted to QA inspector
        - Compression cylinders: In addition to PCI and NPCA requirements, 4 extra cylinders for destressing purposes should be casted.

- QA Inspection:
  - Inspector Qualification: Same requirements as put forth for QC technicians.
  - Independent Assurance (IA): All inspectors should be independently assured once a year for all sampling and testing conducted by them.
  - Pre Pour Inspection: A combined version of the currently in use checklists is proposed to be used.
    - The first step of the pre-pour inspection process involves checking the calibration of the equipment that is being used during the production process. This includes but is not limited to cement scales, aggregate scales water and air meter stressing jack and gauges and cylinder compression tester.
    - The second step of the pre-pour inspection includes the inspection of the pre-stressing strands for PSE and reinforcing bars for PCE used in the element.
    - The third aspect of pre-pour procedure is the form inspection of the particular element.
  - Plastic Concrete Testing:
    - Same testing methods as the QC procedure are required for agency inspection (QA), however infrequent sampling and testing is needed than QC.
    - For PSE and structural PCE, the appropriate tests should be performed every 150 CY or at a minimum of once per element.
    - Non-Structural PCE, the appropriate tests should be performed at least once per continuous pour.
    - Inspectors should conduct verification testing on plastic concrete as opposed to only witnessing QC testing
  - Destressing or Detensioning of PSE: It is recommended that the inspector approve PSE to be destressed on the basis of strength results and be present for destressing. The test specimens used for destressing strength test should be cured in manner similar to the actual element (preferably cured with the element itself).
  - Post-Pour or Stripped Element Inspection: Similar to pre-pour inspection, a combined version of the current check lists of various agency checklists is recommended to be used.
  - Defect and Repair: The current process for fabricators to file non-conformance reports and repair plans are quite similar. Having a standard manual with large database of pictures showing defects and videos with defect identification would aid in ensuring consistency between agencies. At present, agencies allow use of PCI recommended repair procedures (after approval from design engineer), thus there is similarity between current practices.
- Curing Requirements:
  - Since accelerated curing is current state of the practice for PSE and structural PCE it is recommended that the parameters associated with curing follow PCI MNL-116.
  - Non-structural PCE should be cured per agency requirements.

- If the accelerated heat (steam) curing is used, concrete should be maintained in warm and moist conditions while releasing the strands. This eliminates the risk of creation of any tensile stress due to contraction of concrete after the heat curing while the strands are still in tension.

- Hardened Concrete Testing:
  - Compression cylinders for PSE and structural PCE should be fabricated at a minimum of once per element or 150 CY with 6 total cylinders for compression and permeability testing.
    - 2 additional cylinders should be fabricated for stripping strength.
  - Six compression cylinders for non-structural PCE should be fabricated once per continuous pour for strength testing.
  - Testing of permeability is only used by 2 states, it is recommended that this be required for all PSE and structural PCE in the proposed unified acceptance process. Use of surface resistivity test is recommended due to ability of using strength specimens for testing as well as low equipment cost and quicker test time.
- Sampling and Testing of Constituent Materials and Mix Designs:
  - Constituent materials are included in the pre-pour checklist and are recommended to be inspected in conjunction with QC procedures.
  - The sampling and testing of constituent materials is predominantly tied to the current agency concrete material specifications. It is proposed that concrete mix design requirements be unified as part of common acceptance standards.

6.3 Final Remarks

This review showed the various discrepancies in the quality control procedures that are currently in use by the six New England Transportation agencies. Throughout the review, the findings showed the possibility of creating a unified quality assurance specification to be implemented for PSE and PCE that are used in highway construction. The aforementioned recommendations for the proposed specifications could be used to limit the cost of inspection amongst the agencies by utilizing shared inspectors that could ultimately perform work for multiple agencies during the work day. This would prevent the surplus of inspectors at a given plant performing similar inspections. The next step in this effort would be to develop a cost-sharing mechanism for the agencies to be able to appropriately allocate the cost of inspection for the correct elements. This cost-sharing mechanism is being explore din the phase-II of this project. After a cost-sharing mechanism has been developed, it is important to implement a pilot plan to refine the recommended procedures to ensure a smooth transition for the various agencies.

7. References

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Appendices

Appendix-A: Questionnaire for interview with agency personnel to review QA processes.

Appendix-B: Transcribed interviews in abridged format.

Appendix-C: Master table with information gathered from review of QA processes.

Appendix-D: QA inspector office and facility requirements.

Appendix-E: Checklists for plant qualification and audit.

Appendix-F: Checklists and daily report forms for QA inspection.

NETC 13-3: Improved Regionalization of QA Functions

Questionnaire for QA Process Interviews

GENERAL PROGRAM LEVEL:

1. What are the specifications (standards) and/or details that your agency uses for precast/prestressed concrete elements (PCE/PSE)?

2. What additional specifications (standards) are utilized in above standards and/or details for items such as steel reinforcement, concrete etc.?

3. What is your agency's acceptance plan for PCE/PSE? Has this plan been approved by FHWA?

INITIAL AND RECURRENT QUALIFICATION OF PRODUCERS:

1. Does your agency evaluate PCE/PSE suppliers and their products for inclusion in a Qualified Products List?

If yes:

a. Please discuss the prequalification process.
b. How often does a product or producer have to be requalified?

If no:

a. If your agency does not use qualified product list, how are the PCE/PSE suppliers evaluated?

2. How many PCE/PSE plants are approved to fabricate elements for your agency?

PLANT AND QC PROCEDURE REVIEW:

1. Does your agency review PCE/PSE producer's plants? If yes, what specific items are reviewed and is there a standard checklist?

2. Does you agency use a third party certification organization for plant review? If yes, which organization?

3. Does your agency review producer's QCM or QC Plan?
    a. What requirements are put forth to be included in QCM or QC Plan?
    b. Is there a formal acceptance or rejection process?
    c. How frequent is a QCM or QC Plan reviewed for each plant?
    d. Are technicians required to be qualified, if so, what are the requirements?
        i. Do you rely on regional or national certification program? If so, which ones?
        ii. Does your agency have its own technician certification program?
        iii. Are there different levels of certifications that you require? (example: sampling and testing, mix design and batching)

e. Is testing equipment required to be verified and calibrated? If so, what are the requirements and frequency?

f. What are the requirements for curing?

4. What type of production records are required to be kept by manufacturer?

INSPECTION:

1. Is an inspector required to be present at the plant on a full time or part time basis?

2. Does agency or consultant staff conduct certification/training of inspectors on its own or rely on regional/national certification programs? Which regional/national programs are used?

3. Are same inspections processes used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspections?

4. Are same inspectors used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspector certifications?

5. Are their checklists that are provided to inspectors? If so, please share them.

6. What aspects of PCE/PSE inspected?
   (Dimensions; steel reinforcement (steel certification and testing records, reinforcement placement, anchoring, jacking); concrete (material and mix design records, test results); visual inspection of defects etc.)

7. Are their daily reports that inspectors complete? Please provide a sample.

8. Are the same inspectors associated with the other forms of acceptance testing to determine if the element meets the standards (such as compressive strength tests on concrete)?

9. What happens when defects are noted? What is you non-compliance procedure?

10. How much is part time inspection? Full time? When inspector is at the plant what processes are observed/inspected?

VERIFICATION TESTING:

1. What are your agencies requirements for verification testing?

    a. What items are required to be tested and what is the frequency for them?

    b. Where is this testing typically conducted?

    c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

    d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan for products that fail the verification testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

8. How do you finally accept something?

INDEPENDENT ASSURANCE TESTING:

1. What are your agencies requirements for IA testing?

    a. What items are required to be tested and what is the frequency for them?

    b. Where is this testing typically conducted?

    c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

    d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan if the IA testing fails?

3. What documentation is generated throughout the IA process?

4. Does your agency use any cored samples from the PCE/PSE element as part of IA testing?

OVERALL

1. What would you like to see added to the current specifications pertaining PCE/PSE? Removed?

NETC 13-3: Improved Regionalization of QA Functions
<u>CT DOT Questionnaire 10/16/15</u>
<u>Questionnaire for QA Process Interviews</u>

GENERAL PROGRAM LEVEL:

1. What are the standards and/or details that your agency uses for precast/prestressed concrete elements (PCE/PSE)?

July 2015-
Precast concrete 5.07. 5.14 PS

2. What additional standards are utilized in above standards and/or details for items such as steel reinforcement, concrete etc.?

PC box culverts are all special provisions
Concrete arches special provisions
PCC is producer designed

3. What is your agency's acceptance plan for PCE/PSE? Has this plan been approved by FHWA?

Yes, PDF file on shared folder.

INITIAL AND RECURRENT QUALIFICATION OF PRODUCERS:

1. Does your agency evaluate PCE/PSE suppliers and their products for inclusion in a Qualified Products List?

Admixtures: conformance to AASHTO/ASTM. Internal list of qualified admixtures.

If yes:

a. Please discuss the prequalification process.
b. How often does a product or producer have to be requalified?]

Does not require NPCA or PCI certification
Requires CT DOT inspection
Annually, list of plants that are approved and qualified.

If no:

a. If your agency does not use qualified product list, how are the PCE/PSE suppliers evaluated?

2. How many PCE/PSE plants are approved to fabricate elements for your agency?

PA, VA (long time ago), MA, ME, VT.

PLANT AND QC PROCEDURE REVIEW: None for PC Plants. PCI MNL 116 for PS

1. Does your agency review PCE/PSE producer's plants? If yes, what specific items are reviewed and is there a standard checklist?

Annual plant inspection.

Pre cast: Do not require NPCA and/or PCI….most have it anyway.
2 plants in CT that are not certified.

Pre Stressed: they must have QC plan according the PCI MNL 116

2. Does you agency use a third party certification organization for plant review? If yes, which organization?

Only for QSM requirement.

3. Does your agency review producer's QCM or QC Plan?
    a. What requirements are put forth to be included in QCM or QC Plan?
    b. Is there a formal acceptance or rejection process?
    c. How frequent is a QCM or QC Plan reviewed for each plant?
    d. Are technicians required to be qualified, if so, what are the requirements?

QC tests need to be ACI certified

        i. Do you rely on regional or national certification program? If so, which ones?
        ii. Does your agency have its own technician certification program?

No. just for Connecticut DOT people. Administered by UConn/CAP Lab

        iii. Are there different levels of Qualifications that you require? (example: sampling and testing, mix design and batching)

e. Is testing equipment required to be verified and calibrated? If so, what are the requirements and frequency?

1/year as per MAT-324

f. What are the requirements for curing?

No. they possibly have notes in there but do not inspect any aspects of it.

4. What type of production records are required to be kept by manufacturer?

INSPECTION: Both consultants and inspectors

General Notes:

How many cylinders? None required. They rely on contractors results after being witnessed by inspector.

Inspectors with more experience would be more likely to inspect structural items. Higher risk.

Work along with the QC person to inspect pre pour

They do not have to be at the pour but they try to be.

Curing restrictions? No restrictions. Curing is in accordance with MNL 116.

Defect procedure: notable observation write-up, NCR from contractor. Forwarded to project engineer. Then submit repair procedure.

Verification testing on steel? No prescribed frequency, but grab reinforcing steel for testing at central lab every once in a while

Aggregates: randomly sampled but plants typically do it themselves. Gradation/moisture

Central Lab calibration: AMRL certified. And NETTCP.

Core Samples? Not for acceptance. Only for forensics if they got questionable results.

Non-destructive? Surface resistivity testing – no. none, just strength.

Inspector documents? Yes, they keep documents on each element that can be given to resident engineer at request.

Inspector not required to witness loading. No stamps.

Last time witnessed when it is in the stockyard. They do not make specific trips to witness loading.

Final acceptance: component is accepted when project is accepted.\
Accepted on component level not on project level.

In house inspectors? Roughly 3 that also have different jobs
Consultants? None right now.

Consultant inspector qualifications? Will be given to us

Hourly Rates? Will be provided.
They get billed on hours and their travel

1. Is an inspector required to be present at the plant on a full time or part time basis?

Both. Mostly in house this year but they do utilize consultants.
Only witness plastic tests. Do not run them themselves.
Inspector IA – not in the spec. They do not run tests so they do not IA them.

Total contract for consultants is typically 3 years. Within the 3 year it is just for the duration of the project.

2. Does agency or consultant staff conduct certification/training of inspectors on its own or rely on regional/national certification programs? Which regional/national programs are used?

Same level of certification. They require ACI (not UConn) for the consultants.

3. Are same inspections processes used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspections?

Not drastically different.
Pre cast: They do pre-pour, observe QC run fresh properties/ cast cylinders/ post pour.

They do not have to witness detensioning. They do not want to hold them up.

They ask them to break cylinder when they do arrive and can verify their data based upon that.

4. Are same inspectors used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspector certifications?

5. Are their checklists that are provided to inspectors? If so, please share them.

No checklist. Follow shop drawings and QC plan.
Consultants have checklists. Consultants provide their own checklist.

6. What aspects of PCE/PSE inspected?
   (Dimensions; steel reinforcement (steel certification and testing records, reinforcement placement, anchoring, jacking); concrete (material and mix design records, test results); visual inspection of defects etc.)

All of the above. Do not have to be present for pour.

No acceptance cylinders, ONLY WITNESS

7. Are their daily reports that inspectors complete? Please provide a sample.

Consultants provide a checklist.
In house – project basis they turn in a sheet.

8. Are the same inspectors associated with the other forms of acceptance testing to determine if the element meets the standards (such as compressive strength tests on concrete)?

May be on basis of experience level, but normally the same person for PC and PS.

What happens when defects are noted?
MAT-107. QC will send nonconformance report – repair procedure.

9. How much is part time inspection? Full time?

VERIFICATION TESTING:

All components are sampled at no prescribed frequency. Steel rebar and strands are tested.

Aggregates – randomly sampled (sometimes)

1. What are your agencies requirements for verification testing?

a. What items are required to be tested and what is the frequency for them?

b. Where is this testing typically conducted?

c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan for products that fail the verification testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

Not for acceptance

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

Yes.

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

Not required to witness
No stamping
Standard drawings – PC components form filled by PC-1 – accompanying documentation

8. How do you finally accept something?

Acceptance is part of the project acceptance.

INDEPENDENT ASSURANCE TESTING:
No IA required. Inspectors do not run any tests.

1. What are your agencies requirements for Independent Assurance testing?

    a. What items are required to be tested and what is the frequency for them?

    b. Where is this testing typically conducted?

    c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

    d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan for products that fail the IA testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

2 ½ in house
No consultants right now.

SCMs requirement have to meet PCC spec.

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

8. How do you finally accept something?

OVERALL

1. What would you like to see added to the current standard? Removed?

Still need oversight on consultant inspection.

Things to change:
Like to see more requirements for the actual mixes. They currently do not have any control of the mix they just need to meet certain specs.
They go with history based aggregates. No known ASR reactions and they just take that.

Add in some higher requirements like permeability and surface resistivity. Not just the normal air slump etc.

They have maximum % for cementitious materials.

Winter curing

Possibly created a high and low strength limit

Design Build –still perform QA on those things.

Things to remove:
36 hours after tensioning must be poured. If not you must retension. Maybe follow the PCI 48 hours.

Requested specifications. Standard is 2004 but updated 2 years.
Construction spec leads to both PC and PS materials spec.
Modified plans per project but also refer to the standard spec.

Do not approve any mix designs. The actual mixes are submitted but they are ultimately responsible for performance.

Qualified Plant List to be provided.

Calibration- once per year.

NETC 13-3: Improved Regionalization of QA Functions
<u>MassDOT September 30th, 2015</u>
<u>Questionnaire for QA Process Interviews</u>

GENERAL PROGRAM LEVEL:

1. What are the standards and/or details that your agency uses for precast/prestressed concrete elements (PCE/PSE)?

MassDT online specification. Online standard drawings. 2014 reissued them
Redrawn in 1995

2. What additional standards are utilized in above standards and/or details for items such as steel reinforcement, concrete etc.?

M section, requirements for concrete. Every plant has a mix that gets approved.

3. What is your agency's acceptance plan for PCE/PSE? Has this plan been approved by FHWA?

No, because it is being worked on right now.
None prior either.

INITIAL AND RECURRENT QUALIFICATION OF PRODUCERS:

1. Does your agency evaluate PCE/PSE suppliers and their products for inclusion in a Qualified Products List?

Prestressed PCI MNL 116
PC it is NPCA, or PCI.

Step 2.) MassDOT still goes and does an audit of the plant. Includes looking at QSM and QC facilities.
Audit could be consultants or in house.
Checklist? They will give us a copy.
In the past they have qualified once as long as they maintain PCI which is annual.
Future: Annually.

If yes:

a. Please discuss the prequalification process.

Above.

b. How often does a product or producer have to be requalified?

Above.

If no:

a. If your agency does not use qualified product list, how are the PCE/PSE suppliers evaluated?

On the website. Qualified materials list. Separated by precast and prestressed.

2. How many PCE/PSE plants are approved to fabricate elements for your agency?

22 companies –around 26 plants for precast and prestressed.
The list changes

New England and New York and currently Canada. Canadian buys American steel.

PLANT AND QC PROCEDURE REVIEW: MNL 116

1. Does your agency review PCE/PSE producer's plants? If yes, what specific items are reviewed and is there a standard checklist?

In past: Qualified once. Plants are so long as they maintain PCI or NPCA.
In future: Annual Qualification

2. Does your agency use a third party certification organization for plant review? If yes, which organization?

PCI or NPCA and then followed by a MassDOT audit.

3. Does your agency review producer's QCM or QC Plan?
    a. What requirements are put forth to be included in QCM or QC Plan?

Does not give specific information.

    b. Is there a formal acceptance or rejection process?

    c. How frequent is a QCM or QC Plan reviewed for each plant?

    d. Are technicians required to be qualified, if so, what are the requirements?

        i. Do you rely on regional or national certification program? If so, which ones?

It is Spec M- possibly ACI 1 and 2 and others.

        ii. Does your agency have its own technician certification program?

No.

        iii. Are there different levels of Qualifications that you require? (example: sampling and testing, mix design and batching)

e. Is testing equipment required to be verified and calibrated? If so, what are the requirements and frequency?

f. What are the requirements for curing?

4. What type of production records are required to be kept by manufacturer?

They need to submit a concrete mix approval.
Sample aggregates, cements, random steel (rebar, mesh, strands), they do not sample admixtures all as part of plant certification.

INSPECTION: Consultants
What are inspectors doing at plant?

- Approved plans and mix design
- Pre pour inspection. Involves reinforcement and dimensions
- Placement. They do all their own fresh testing and casting cylinders.
  - Frequencies- 1 per mix per day
  - How many cylinders?
    - 9 cylinders per casting, all get sent to central lab. 3 at 7 3 at 28 and 3 at 56.
    - They can use their own cylinders as long as inspector is watching.
    - No standard frequencies because of special specs.
  - They go by the inspector's results if there is a discrepancy.
- Precast: cylinders broken for release from forms. Witnessed by inspector.

1. Is an inspector required to be present at the plant on a full time or part time basis?

Inspector needs to be present during destressing to measure camber.

2. Does agency or consultant staff conduct certification/training of inspectors on its own or rely on regional/national certification programs? Which regional/national programs are used?

They have 4 companies) consultant inspectors that do all the work for them.

Same inspectors are used for both precast and prestressed. Can be same person because it is same qualifications.

PCI level 2 for both PC and PS

3. Are same inspections processes used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspections?

They don't inspect stock items all the time, it is done periodically.
Could be once a year could be more. Something they are looking into for new program.

4. Are same inspectors used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspector certifications?

Consultant scope document is provided.
They have 3 rates. Hourly, overtime, and materials delivery rate.

They are currently working on curing requirements for inspection.

5. Are their checklists that are provided to inspectors? If so, please share them.

Relatively bland.
Inspector is present for detensioning and camber measurement.
Allow PCI repair procedures
Plant submits repair plans, gets approved by MassDOT

6. What aspects of PCE/PSE inspected?
   (Dimensions; steel reinforcement (steel certification and testing records, reinforcement placement, anchoring, jacking); concrete (material and mix design records, test results); visual inspection of defects etc.)

7. Are their daily reports that inspectors complete? Please provide a sample.

They can provide a sample of the reports for both prestressed and precast.

   Daily inspection sheet
   Random number sheet
   Copy of batch ticket
   PS – elongation sheet: jacking report
   Temperature recordings –
   Keep notebook of the project at the plant and that is submitted at end of project. Earlier if there is an issue.
   Photos
   Mill certs
   COC's

8. Are the same inspectors associated with the other forms of acceptance testing to determine if the element meets the standards (such as compressive strength tests on concrete)?

Contract is PC PS inspection of plant fabrication

9. What happens when defects are noted? Non-compliance procedure?

Utilize PCI repair procedures. Inspector's responsibility to submit NCR. Post repair inspector checks it.

10. How much is part time inspection? Full time?

Last time inspector sees component?

Ideally witness it loaded. However not always the case because sometimes they are shipped 6-12 months later.

They have a certificate of compliance (certificate is the responsibility of the plant to come up with) that must be signed. They take pictures and videos. This way the person in the field can see the date and the item and make sure it is correct.

How many inspectors per year?

8-10

About 4-5 are steady the others come and go.

They have been using consultants for about 15 years.

Inspector is there he is inspecting everything that is going on. They have 2 at one plant at one time, the most. They are there the whole day. Work the same hours as plant.

Additional concerns about inspection:

Shop drawings for standard shapes:

The fabricator use the drawing from a different state the question is does our inspector know what is accepted and what is not for MA.

VERIFICATION TESTING: Done by consultant companies.

1. What are your agencies requirements for verification testing?

    a. What items are required to be tested and what is the frequency for them?

Scope will tell as to what is tested.

    b. Where is this testing typically conducted?

    c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

Plant qualification- at the beginning.

d. At what time during the project process this testing is conducted and what is typical turnaround time?

They ask for results everyday usually for shipping purposes. Usually sent to them on a failure basis.

2. What is your agency's standard plan for products that fail the verification testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

Go off on inspectors results only.

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

If they get bad breaks at 28 and then 56, then there is an option to core. They really try to not core. Maybe once a year.

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

None used right now.

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

The field will call if they have problems with what they have received.

8. How do you finally accept something?

On site, when the project is accepted.

INDEPENDENT ASSURANCE TESTING:

1. What are your agencies requirements for Independent Assurance testing?

Goal is to do each inspector once per year.

a. What items are required to be tested and what is the frequency for them?

Includes: only on testing not on the pre pour etc.

b. Where is this testing typically conducted?

Break rebar, break them here and it is randomly selected from random number sheet.

c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan for products that fail the IA testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

8. How do you finally accept something?

OVERALL

1. What would you like to see added to the current standard? Removed?

- More defined IA schedule for precast. We currently have a random approach.
- QC plans vary even though most plants use PCI MNL 116
- Inspector's office requirements are in the spec.
- Inspect for 2 agencies in one day?
  - Discouraged whenever people ask.
- Who breaks cylinders here?
  - 3 different ways, either brought here, broken there, or shipped here.
  - In the contract.
- Cement is part of annual process

- Aggregates: specific gravity coarse and fine etc.
- ASR testing on aggregates. Part of annual

- Specs- Online

- Scope of inspector – will be given

- Price range – will be given

- Prequalified list – online

- Sample of inspector reports – will be given

- 305 – pre-cast retaining walls – but are actually cast in place.

- Annual letter

NETC 13-3: Improved Regionalization of QA Functions

Questionnaire for QA Process Interviews
Maine Department of Transportation
June 3rd, 2015

GENERAL PROGRAM LEVEL:

1. What are the standards and/or details that your agency uses for precast/prestressed concrete elements (PCE/PSE)?

534, 535, 526, 509, 674, 681, 712.061
603, 604

2. What additional standards are utilized in above standards and/or details for items such as steel reinforcement, concrete etc.?

502 – (Structural PCC) Class P is typical
535 – Does not refer back (stand alone)
503 – Reinforcing steel
703 – PCC aggregate FA and CA. Section dealing with ASR and Admixtures.

3. What is your agency's acceptance plan for PCE/PSE? Has this plan been approved by FHWA?

Yes, copy has been provided to researchers.

INITIAL AND RECURRENT QUALIFICATION OF PRODUCERS:

1. Does your agency evaluate PCE/PSE suppliers and their products for inclusion in a Qualified Products List?

No.

If yes:

a. Please discuss the prequalification process.

535 – PCI
534 – NPCA
MEDOT has prequalified sometimes

b. How often does a product or producer have to be requalified?

If no:

a. If your agency does not use qualified product list, how are the PCE/PSE suppliers evaluated?

MEDOT does not used a qualified product list.

2. How many PCE/PSE plants are approved to fabricate elements for your agency?

535 – 1 in Maine. 5 outside of Maine. 6 Total – Stresscon, Erwin Ultrastream
534 – 5 in Maine, 1 in Mass, 1 in Canada. 7 Total

PLANT AND QC PROCEDURE REVIEW:

1. Does your agency review PCE/PSE producer's plants? If yes, what specific items are reviewed and is there a standard checklist?

AASHTO M157
Min 5 years producing type of product
Annual inspection
    Standard checklist
    Testing info management system

We will get a copy of this.

2. Does you agency use a third party certification organization for plant review? If yes, which organization?

535 PCI MNL 116
534 – AASHTO M157. NPCA – nonprestressed
502 – National ready mix

3. Does your agency review producer's QCM or QC Plan?
    a. What requirements are put forth to be included in QCM or QC Plan?

534 – In Specification
535 – in PCI

    b. Is there a formal acceptance or rejection process?

Generally not.

    c. How frequent is a QCM or QC Plan reviewed for each plant?

There is not a time line.

    d. Are technicians required to be qualified, if so, what are the requirements?

        i. Do you rely on regional or national certification program? If so, which ones?

535 – PCI level 1 – PC. Level 2 PS
534 – ACI Certification

ii. Does your agency have its own technician certification program?

No.

iii. Are there different levels of Qualifications that you require? (example: sampling and testing, mix design and batching)

ACI different levels for 503/502
Optional NETTCP
ACI Level 1

e. Is testing equipment required to be verified and calibrated? If so, what are the requirements and frequency?

Yes, 535 PCI, except stressing test every 6 months. PCI is 2 months.
534 Table in spec
502 freq for QC in spec.

f. What are the requirements for curing?

Found in the specification

4. What type of production records are required to be kept by manufacturer?

535 – Table in spec (list provided by Kevin)
534 – Table in spec

INSPECTION:

Both State employees and consultant inspections.

1. Is an inspector required to be present at the plant on a full time or part time basis?

535- per spec (witness) tensioning, detensioning, placement, cylinder testing.
534 – per spec. prepour, post pour, reinforcing

2. Does agency or consultant staff conduct certification/training of inspectors on its own or rely on regional/national certification programs? Which regional/national programs are used?

535 – same as QC technician
534 – ACI is required (PCI is preferred)
PS – PCI Level 2
PC – PCI Level 1

3. Are same inspections processes used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspections?

534 – 712.061 same as PC

Minimal inspection on non-structural items.

4. Are same inspectors used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspector certifications?

PS – Level 2 PCI
PC – Level 1 PCI

5. Are their checklists that are provided to inspectors? If so, please share them.

Yes, samples are provided.

6. What aspects of PCE/PSE inspected?
   (Dimensions; steel reinforcement (steel certification and testing records, reinforcement placement, anchoring, jacking); concrete (material and mix design records, test results); visual inspection of defects etc.)

535

7. Are their daily reports that inspectors complete? Please provide a sample.

Statement of expectations in the folder.

8. Are the same inspectors associated with the other forms of acceptance testing to determine if the element meets the standards (such as compressive strength tests on concrete)?

Either PCE/PSE. Not typical to do both. 502

9. What happens when defects are noted? Non-compliance procedure?

PC or PS – non-compliance language (534 and 535)
106- Reduced to make acceptance
Remedial action to make sure nonconformance does not happen continuously.

10. How much is part time inspection? Full Time? When inspector is at the plant what processes are observed/inspected?

Could be inspecting more than one but usually full time inspection of one location.

VERIFICATION TESTING:

1. What are your agencies requirements for verification testing?

   a. What items are required to be tested and what is the frequency for them?

They are in spec.

b. Where is this testing typically conducted?

535 – First 2 loads be tested for acceptability and if they meet then OK. If not, continue until 2 consecutive loads are accepted.

c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

MRL Certified.
Testing done at central lab
Gradation at both facility.

d. At what time during the project process this testing is conducted and what is typical turnaround time?

1-2 days of the 28 days.

From each project:
Per week of production
-2 cylinders for strength
-4 cylinders for permeability
-ready mix
-1 gradation before production
-strength and permeability: 28 day. Unless fly ash is present then 56 day.

2. What is your agency's standard plan for products that fail the verification testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

Initial failure: Resample
If they are still in the process of casting then the appropriate adjustments should be made.

3. What documentation is generated throughout the process?

Yes, in lab management system.
This information is not always shared with the producer.

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

Only time cored samples are done is when there is a dispute process.
Cored samples for non-structural and cast in place items: Precast pipes, 603, 604. Part of acceptance for 603 and 604.

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

Yes, some Ground Penetrating Radar to find the cover thickness.

6. Does acceptance of the component happen in steps or not?

Yes. Document.

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

If finishing requirements than last item inspected is finish.
If schedule allows that they see them get loaded, otherwise when they are stored on site. This is usually documented.
Repair: QSM has generic procedure, manufacturer has to submit repair plan that has to be approved by fabrication engineer.

8. How do you finally accept something?

When project is accepted by R.E. (Resident Engineer)

INDEPENDENT ASSURANCE TESTING:

1. What are your agencies requirements for Independent Assurance testing?

No real requirement put forth. Routine PCC testing takes care of it.

   a. What items are required to be tested and what is the frequency for them?

   b. Where is this testing typically conducted?

   c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

   d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan for products that fail the IA testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

Only witness QC

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

712.061 – window for acceptance: Air content 5.5%-7.5% but allowed outside of that if other project requirements are met.

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

8. How do you finally accept something?

OVERALL

1. What would you like to see added to the current standard? Removed?

Language about "..this is not allowed or acceptable.." Maybe add "Do this to fix or do this to address."

GPR testing for cover thickness can be added.

For precast elements – only ACI level 1 certification is currently required, but do not know how to read shop drawings.

Precast plant inspection required (NETTCP or other)

Maine – No tasks are actually run by inspector, only witness the tests being done.

Certified versus qualified

Sometimes performance of QA inspection is monitored on design-build projects.

Sometimes there is not apparent commitment to quality.

Accelerated curing requirements

After meeting initial set:

-Accelerate cure for 8 hours

-80% design strength for no additional curing requirement

- 120 degree Fahrenheit temperature

If any of those three are not met they have to cure to full design strength.

Allowable use of curing compound should be corrected or struck out.

If release strength is less than 80% of design strength, then they will have to continue to cure after release.

Hired Consultant:

- General consultant agreement
- 3 year contract
- Paid hourly. General assignment letters.

NETC 13-3: Improved Regionalization of QA Functions

Questionnaire for QA Process Interviews

New Hampshire Department of Transportation
May 15th, 2015

GENERAL PROGRAM LEVEL:

1. What are the standards and/or details that your agency uses for precast/prestressed concrete elements (PCE/PSE)?

520, 528, 574 (wall item), 604 (catch basins), 603 (pipe), 606 (guard rails), 594 MSE

2. What additional standards are utilized in above standards and/or details for items such as steel reinforcement, concrete etc.?

520 and 544 (steel)

3. What is your agency's acceptance plan for PCE/PSE? Has this plan been approved by FHWA?

Does not have a routine cycle. Approved in 2010.

INITIAL AND RECURRENT QUALIFICATION OF PRODUCERS:

1. Does your agency evaluate PCE/PSE suppliers and their products for inclusion in a Qualified Products List?

No. They do not have a list.

If yes:

a. Please discuss the prequalification process.
b. How often does a product or producer have to be requalified?

If no:

a. If your agency does not use qualified product list, how are the PCE/PSE suppliers evaluated?

Specification says the fabricator should be able to prove they can produce a quality item.

2. How many PCE/PSE plants are approved to fabricate elements for your agency?

Producers: 5 total, Avon, Rotundo…

PLANT AND QC PROCEDURE REVIEW:

1. Does your agency review PCE/PSE producer's plants? If yes, what specific items are reviewed and is there a standard checklist?

Specification controls it. Curing would be under curing specifications.

2. Does you agency use a third party certification organization for plant review? If yes, which organization?

PCI only. NPCA not required although most fabricators have it. NPCA website says NH requires it however they do not require NPCA.

3. Does your agency review producer's QCM or QC Plan?
    a. What requirements are put forth to be included in QCM or QC Plan?

Does not need to be submitted but must have it on hand.

    b. Is there a formal acceptance or rejection process?

N.A.

    c. How frequent is a QCM or QC Plan reviewed for each plant?

N.A.

    d. Are technicians required to be qualified, if so, what are the requirements?

NHDOT has no additional requirements for the technicians at the facilities.

        i. Do you rely on regional or national certification program? If so, which ones?
        ii. Does your agency have its own technician certification program?
        iii. Are there different levels of certifications that you require? (example: sampling and testing, mix design and batching)

    e. Is testing equipment required to be verified and calibrated? If so, what are the requirements and frequency?

Defined in the specifications. Ex. 100, 520... Item specific)

    f. What are the requirements for curing?

Item specific. Controlled by specifications.

4. What type of production records are required to be kept by manufacturer?

Governed by the plant certification process. NH does not require but they might be governed by their QC plan.

INSPECTION:

1. Is an inspector required to be present at the plant on a full time or part time basis?

528: Inspector is required to be present at all times. (Forming, pouring, curing, loading on trucks.) Risk assessment on how much inspection that needs to happen.
What is inspected? 528 beams, 520 box culverts, 606 barriers, 594 MSE, 604 special items, 597 T-Walls.

2. Does agency or consultant staff conduct certification/training of inspectors on its own or rely on regional/national certification programs? Which regional/national programs are used?

NHDOT hires consultant inspectors. PCI level II required for everything no matter what is being inspected. Eventually will accept either NETTCP or PCI.

3. Are same inspections processes used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspections?

4. Are same inspectors used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspector certifications?

5. Are their checklists that are provided to inspectors? If so, please share them.

They are available to us (possibly in email). Also accept consultants because they use a similar checklist on a tablet.

6. What aspects of PCE/PSE inspected?
   (Dimensions; steel reinforcement (steel certification and testing records, reinforcement placement, anchoring, jacking); concrete (material and mix design records, test results); visual inspection of defects etc.)

Every aspect is to be inspected.

7. Are their daily reports that inspectors complete? Please provide a sample.

At the end of the project, full report is submitted at the end. Includes daily reports.

8. Are the same inspectors associated with the other forms of acceptance testing to determine if the element meets the standards (such as compressive strength tests on concrete)?

Inspectors are responsible for all fresh concrete tests. They do create the cylinders but they are not the people to break them.

9. What happens when defects are noted? Non-compliance procedure?

Defect triggers a phone call, followed by a report. The report goes into the daily report with a picture, decide on a repairable or non-repairable, produce a repair plan. It is covered in the specifications but not clearly laid out.

10. How much is part time inspection? Full time?

Previously covered.

VERIFICATION TESTING:

1. What are your agencies requirements for verification testing?

Occasionally break rebar. Aggregate gradation is done. Very rare to test cement. All in all not too much verification testing.

   a. What items are required to be tested and what is the frequency for them?

Steel*, Aggregate tests, Admixtures for NETPEP, ASR*

*- hard to read

   b. Where is this testing typically conducted?

NHDOT

   c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

AASHTO

   d. At what time during the project process this testing is conducted and what is typical turnaround time?

Random

2. What is your agency's standard plan for products that fail the verification testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

Step 1: Re-test, case-by-case.

3. What documentation is generated throughout the process?

Goes into laboratory management system.

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

Only if an acceptance test was failing. Depends on item and accessibility.

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

No routine non-destructive testing. NHDOT prefers cores if there is a failure. If cores are not available then they will use NDT.

6. Does acceptance of the component happen in steps or not?

Acceptance results are available to the manufacturer but the records are not sent to them.

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

8. How do you finally accept something?

INDEPENDENT ASSURANCE TESTING:

1. What are your agencies requirements for Independent Assurance testing?

Once per year per inspector (system based) for each test that they perform.

   a. What items are required to be tested and what is the frequency for them?

   b. Where is this testing typically conducted?

All acceptance testing is done at the NHDOT Concord Lab.
No IA on NHDOT employees itself (cylinder breaking)

   c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

Their lab is required to be accredited which would include proper calibration. However, NH does not require it but the accreditation should.

   d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan for products that fail the IA testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

Try to find the cause and remedy the problem. They would need to pass IA before finishing the project.

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

Acceptance happens in steps. At each step there has to be a green light.

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

PSE – when it is on the truck.
PCE – when stacked or stored in the yard. For PCE, only producer stamps and the inspector would say all pieces from that date are accepted.

8. How do you finally accept something?

When the project is accepted. Repair is mostly covered by PCI 11-6

OVERALL

1. What would you like to see added to the current standard? Removed?

Curing procedure/requirements

Responsibility of acceptance tester

Expectations of inspectors (Required list can be made electronic)

Inspector contracts are by bid. They bid for an hourly rate.

NHDOT – Consultant inspectors are contracted for both PSE and PCE

CT, NH, ME – Consultant inspectors only.

2 year contracts with inspectors. 3 are active at any given time.

Concerned with the billing of multiple states. NHDOT would want a submitted timesheet to NH and the timesheet to the other state(s) involved.

IDEA: States take turns as lead for managing inspectors and handling of money.

NETC 13-3: Improved Regionalization of QA Functions

Questionnaire for QA Process Interviews

Rhode Island Department of Transportation
June 9th, 2015

GENERAL PROGRAM LEVEL:

1. What are the standards and/or details that your agency uses for precast/prestressed concrete elements (PCE/PSE)?

Full inspection. QA done by DOT.

701 reinforced concrete pipe, 702, 704, and 705 - Drainage structures. Do full inspections. Moistures, gradations, full inspection on steel. All plastic tests.
Oil separators, vortex – job specific. Special application
Standard details – include all of the necessary specs.
Website has master schedule for all testing.
Pipes they do not do any cored samples

800

- 804 has small precast piles section.
- 809
- 802 if PCC

900

- Curbing: they want to base it per sub lot. 0 slump
- 909 median barriers
- Temporary barriers – try not to because they will use leftover concrete.
- 926, 906,909

T05- Manholes will be a precast item that may refer to 702

2. What additional standards are utilized in above standards and/or details for items such as steel reinforcement, concrete etc.?

600

- 601 has been amended so the blue book is not up to date. The current version is 2010 but the amendments have been made since that time.
- 601,602,603,604,605.

810 - Steel
M01 – aggregates for concrete
M02- PCC. Cement, aggregates, admixtures can be found in M02 as well
M05 – more requirements for steel

3. What is your agency's acceptance plan for PCE/PSE? Has this plan been approved by FHWA?

Do not have formal approval process. FHWA approval is what we submit for List of all the required tests that need to be completed.
Master Schedule on Website.
They are eventually implementing a universal type of application. Hopefully have an approved spec by August and then require people to use it on April 1st next year.

INITIAL AND RECURRENT QUALIFICATION OF PRODUCERS:

1. Does your agency evaluate PCE/PSE suppliers and their products for inclusion in a Qualified Products List?

If yes:

a. Please discuss the prequalification process.

Requirements for a plant to actually do work with us.

601, 809, 930.

We do not specify anything along those lines. 809 has equipment requirements. We require that they have a laboratory on site section 930. Those are the two basic requirements to begin manufacture.

Pre-stressed we do require PCI plant certification ML116.

b. How often does a product or producer have to be requalified?

They do full inspection rather than have a qualified list.

If no:

a. If your agency does not use qualified product list, how are the PCE/PSE suppliers evaluated?

No

2. How many PCE/PSE plants are approved to fabricate elements for your agency?

We have their Approved Asphalt, ready mix, and precast list. They are approved by the section mentioned above. 809 and 903.

They call either Chris or Joe to begin to become approved. This is because they want to break into getting some state work. They need to approve plant and lab and then also approved their mixes.

Right now they have 6 plants that are approved. One plant just recently closed. Only one plant remains within the state. They deal with non-structural items.

Massachusetts and New Hampshire tend to do the most work for RI. CSI in New Hampshire and Old Castle in Massachusetts. Old Castle is fairly close though.

Pre-Stressed – typically comes from Pennsylvania. NorthEast

PCE – NH
PSE - PA

PLANT AND QC PROCEDURE REVIEW:

1. Does your agency review PCE/PSE producer's plants? If yes, what specific items are reviewed and is there a standard checklist?

We have the annual certification checklist. Manufacturer contacts office to be reapproved.

Precast they do most QC in house, meaning they do not require much QC on their part. Nonstructural items driven by checklist and to have the facility on site. Prestressed – Job specific. Standard specs are very generic section 809. Only recently have they asked for a QC plan.

2. Does you agency use a third party certification organization for plant review? If yes, which organization?

PCI Plant Certification
As to how often, RI requires QC plan that depends on job.

3. Does your agency review producer's QCM or QC Plan?
    a. What requirements are put forth to be included in QCM or QC Plan?

Require plant certification for Pre Stress only.
QC technician, some equipment inspections, calibrations, minimum testing frequencies.

    b. Is there a formal acceptance or rejection process?

    c. How frequent is a QCM or QC Plan reviewed for each plant?

During production the plant has to submit QCM.

How often do you check that the plan is still PCI certified?

- RI is basically job specific while other states seem to be mostly system based.
- Chris would like to go towards something like a QC manual with addendums included.

d. Are technicians required to be qualified, if so, what are the requirements?

i. Do you rely on regional or national certification program? If so, which ones?

Precast – No. Mainly because they do most QC themselves.
Prestressed – Job specific item, typically PCI, NETTCP, ACI, NICT

ii. Does your agency have its own technician certification program?

Department- We do not require certification but they do have a qualification program and we do require them to be qualified. Technician is certified and he will go around and take new inspectors out that everyone is performing testing and inspection by the specs.

Nick Melio (sp?) – his job is to qualify the inspectors that work for the department. Mostly all the inspectors are certified however. They use PCI, NETTCP, ACI.

A lot of it is internal training. Then signed off by Nick that you are qualified to do the testing. A lot of their guys are in fact PCI qualified though.

iii. Are there different levels of ~~certifications~~ Qualifications that you require? (example: sampling and testing, mix design and batching)

We have precast inspectors and prestressed inspectors. They can do the testing but they cannot inspect the structure itself.

e. Is testing equipment required to be verified and calibrated? If so, what are the requirements and frequency?

Calibration is established by AASHTO Spec. RI has certain requirements for scales, testing equipment, air meters, slump columns, cement scale.

Batching equipment is what we require to be calibrated. They currently do not strongly enforce the other equipment however they plan to move in that direction.

f. What are the requirements for curing?

Prestressed – 809 and 601. They do allow accelerated curing
Accelerated Curing Requirement- allow certain rate of temperature with steam with a max temp. Continue curing until strength is attained.
Not controlled by minimum time, just the strength requirement.

Precast- typically would not use accelerated curing.

4. What type of production records are required to be kept by manufacturer?

Cement mill certs, any pozzolan, admixtures, chemical. We will be requiring control charts in new spec.
Prestressed – certification requirements, Tensioning records, detensioning

INSPECTION:

1. Is an inspector required to be present at the plant on a full time or part time basis?

PC: Throughout the process. Full time. Even before to test aggregates, moisture.

Prestressed – tensioning, detensioning, release. Whole process

2. Does agency or consultant staff conduct certification/training of inspectors on its own or rely on regional/national certification programs? Which regional/national programs are used?

More of a qualification process within the department. Rarely use consultant inspectors. If it did move to a consultant they would require PCI, ACI, NETTCP. They would like to witness their inspection procedure.

3. Are same inspections processes used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspections?

No

4. Are same inspectors used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspector certifications?

Currently four (including Chris and Joe) that can handle both precast and prestressed. 3 are precast only. Several can do ready-mix plants.

5. Are their checklists that are provided to inspectors? If so, please share them.

On the website.
Chris can get us sample report that are completed for both precast and prestressed items.

6. What aspects of PCE/PSE inspected?

   (Dimensions; steel reinforcement (steel certification and testing records, reinforcement placement, anchoring, jacking); concrete (material and mix design records, test results); visual inspection of defects etc.)

Camber measurements would not be included. Some have camber requirements before shipping but since it is a function of time it cannot be accurately predicted. They might note it at the bottom of the report.

7. Are their daily reports that inspectors complete? Please provide a sample.

Yes, will get samples.

8. Are the same inspectors associated with the other forms of acceptance testing to determine if the element meets the standards (such as compressive strength tests on concrete)?

Inspection jobs happen all at the plant
Materials testing in the lab is done by others in the lab.

9. What happens when defects are noted? Non-compliance procedure?

Repair plan is submitted through the contractor. Everyone has input in it (bridge, materials… etc.)
Typically use PCI repair manual or NPCA. Typically choose to recast the piece.

10. How much is part time inspection? Full time?

They do full time.

VERIFICATION TESTING:

1. What are your agencies requirements for verification testing?

Do not use verification testing on contractor because they do it on their own.
Do not use contractor results so verification does not really apply.
These are projects with QC requirements.

a. What items are required to be tested and what is the frequency for them?

b. Where is this testing typically conducted?

c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

Accreditation program

d. At what time during the project process this testing is conducted and what is typical turnaround time?

Only Compressive strengths, they send back all of the results from their breaks at the DOT.

2. What is your agency's standard plan for products that fail the verification testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

No, looking into resistivity. Should be looking into it when there are cracks or other defects. They will hire consultants with better equipment to perform these types of testing.
Report the crack and allow structural engineer to either repair or reject.

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

Precast – when it is being loaded and ready to be shipped out. They will stamp it for approval.
Prestressed – when it is loaded. Place a tag with number. They should write the number down and the location of the piece.

8. How do you finally accept something?

Final acceptance is in the field.

INDEPENDENT ASSURANCE TESTING:

1. What are your agencies requirements for Independent Assurance testing?

Part of the specification and the policy as accepted by federal highway.
1 person not affiliated that is responsible for checking all of the people who are performing the initial tests.
Labs do not need anything because they are accredited.
They check every person that does acceptance.

   a. What items are required to be tested and what is the frequency for them?

   b. Where is this testing typically conducted?

   c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

Automatic

d. At what time during the project process this testing is conducted and what is typical turnaround time?

All internal QC is completed twice a year. Only if they are producing.

2. What is your agency's standard plan for products that fail the IA testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

Retest process. They would get written up.
If our person fails we can grab them quickly and make them retest.
They have tolerances for the testing.

3. What documentation is generated throughout the process?

Report sent to FHWA once a year.

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

No. Only If there is an issue with compressive strength. They will send a request to do a core.

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

8. How do you finally accept something?

OVERALL

1. What would you like to see added to the current standard? Removed?

Precast

- QC spec coming out. Would like to see that. Which would reduce testing frequencies.
- Certain elements that do not need as much inspection. Curbing, hand holes. Curbing they would want to go to a coring procedure.

Prestressed

- Submit a QC report that they have gone through and checked all the elements in the structure. Verify that they have inspected to have some liability on them.

- Submit a certificate of compliance to the plans the DOT gave them. This way liability is on them.

Concrete

- Accepted solely on compressive strength. They would want more testing requirements for it to be accepted. An example is weak gradation that still makes strength and according to the contract it is accepted.
- Resistivity and air content
- Durability, something you can do within 28-days. Federal agencies are recommending that these be included into pay factor.
- Top and bottom limit of air content because too much air can lead to interconnectivity thus leaving air entrainment and moving more toward permeability.
- Shop precast and site precast need to be distinguished because there is a difference.
- Not many precast decks but they are moving in that direction recently.
- Database is being put together to consolidate all the data.
- Less aggregate testing. Maybe move to a quantity basis instead of a daily basis.
- ASR tolerances should be adjusted for risk.
- W/C ratio after the fact by microwaving. How accurate?
- Design build contracts, how does QA process change?
    - Does not change very much. Except acceptance does change.
- RIDOT charges contractor for inspector travel. 100 miles = 150 dollars for inspection. $500/day for overnight travel. It's a table in the specification.

NETC 13-3: Improved Regionalization of QA Functions

VT Trans October 10th, 2015

Questionnaire for QA Process Interviews

GENERAL PROGRAM LEVEL:

1. What are the standards and/or details that your agency uses for precast/prestressed concrete elements (PCE/PSE)?

Provided to researchers.

2. What additional standards are utilized in above standards and/or details for items such as steel reinforcement, concrete etc.?

Provided to researchers. Sometimes rely on QSM

3. What is your agency's acceptance plan for PCE/PSE? Has this plan been approved by FHWA?

Provided to researchers. Per spec.

INITIAL AND RECURRENT QUALIFICATION OF PRODUCERS:

1. Does your agency evaluate PCE/PSE suppliers and their products for inclusion in a Qualified Products List?

Only the material that is used for repairs needs to be on approved materials list. APL List on website.

If yes:

a. Please discuss the prequalification process.

b. How often does a product or producer have to be requalified?

If no:

a. If your agency does not use qualified product list, how are the PCE/PSE suppliers evaluated?

Approval process of mixture.

2. How many PCE/PSE plants are approved to fabricate elements for your agency?

PLANT AND QC PROCEDURE REVIEW:

1. Does your agency review PCE/PSE producer's plants? If yes, what specific items are reviewed and is there a standard checklist?

PCI qualifies plant. VT Trans does not but they will only allow bids from certified plants.

Facility itself they rely on PCI or NPCA.

Step 2.) They do check the lab, calibration, equipment, etc.
Contract is with the general contractor not with the subcontractor.

2. Does you agency use a third party certification organization for plant review? If yes, which organization?

PCI, NPCA.

3. Does your agency review producer's QCM or QC Plan?
    a. What requirements are put forth to be included in QCM or QC Plan?

PCI
Submit QSM and review it. Then make sure they follow it.

b. Is there a formal acceptance or rejection process?

c. How frequent is a QCM or QC Plan reviewed for each plant?

Once a year or when updated

d. Are technicians required to be qualified, if so, what are the requirements?

PCI Level 1

i. Do you rely on regional or national certification program? If so, which ones?

ii. Does your agency have its own technician certification program?

iii. Are there different levels of Qualifications that you require? (example: sampling and testing, mix design and batching)

e. Is testing equipment required to be verified and calibrated? If so, what are the requirements and frequency?

f. What are the requirements for curing?

Allows accelerated curing. Cannot ship until design strength is obtained.
Stripping strength

4. What type of production records are required to be kept by manufacturer?

INSPECTION:

In House + Consultants. Rougly 2 in house and 4-8 consultants.

1. Is an inspector required to be present at the plant on a full time or part time basis?

Have in-house but also hire consultants as needed.
In House – 2 PC and PS
Consultants – expand up to 6-7 possibly 10 in season.
Initial contract is 2 years plus a possible 2 additional extension
100 $/hour

2. Does agency or consultant staff conduct certification/training of inspectors on its own or rely on regional/national certification programs? Which regional/national programs are used?

Precast PCI 1. Possibly even PCI 2 for complex PC components
Pre stressed PCI 1+2.
In house have same certifications as consultants.

3. Are same inspections processes used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspections?

4. Are same inspectors used for precast versus pre-stressed elements; structural versus non-structural elements; standard versus non-standard elements? If not, what are the differences in inspector certifications?

5. Are their checklists that are provided to inspectors? If so, please share them.

Will be provided with inspector checklist.

6. What aspects of PCE/PSE inspected?

   (Dimensions; steel reinforcement (steel certification and testing records, reinforcement placement, anchoring, jacking); concrete (material and mix design records, test results); visual inspection of defects etc.)

1.) Pre pour meeting 7 days before. Lab checked in advance annually. This is when inspector gets familiar with job/plant.
2.) Forms, dimensions, reinforcement. ALL IN CHECKLIST.
3.) They are there for release, and pre stress and detensioning.

7. Are their daily reports that inspectors complete? Please provide a sample.

Sample will be provided.

8. Are the same inspectors associated with the other forms of acceptance testing to determine if the element meets the standards (such as compressive strength tests on concrete)?

9. What happens when defects are noted? Non-compliance procedure?

- If non-conforming, the contractor must submit a repair plan to be approved, then once it is approved they can fix it then be re-inspected.
- Materials part of the Approved list.
- Inspectors are not required to tell fabricators how to fix.
- Inspectors can use contractor's lab for acceptance testing

10. How much is part time inspection? Full time?

Inspector is there from start to finish.
Inspector watches it get loaded and then stamps with compliance for shipping.

When it arrives it is accepted by resident engineer.
True for all elements.

VERIFICATION TESTING:

1. What are your agencies requirements for verification testing?

   a. What items are required to be tested and what is the frequency for them?

Rebar for acceptance and cylinders at 28 days.
Certifications before the pour.

Mix Design: approved on an annual basis. Must be approved in advance and then can be used for 12 months.

Cement- sent to the lab yearly, but sample from every delivery is to be provided by fabricator to agency.

b. Where is this testing typically conducted?

Contractor's lab. They use the contactors equipment but must be calibrated.

Typically at the lab at contractor but must meet the requirements of calibration among other things.

QLP or AMRL

Accept NETTCP labs.

c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan for products that fail the verification testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

3. What documentation is generated throughout the process?

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

8. How do you finally accept something?

INDEPENDENT ASSURANCE TESTING:

VT Trans – has an IA team at the central lab.
Non-compliance is reported to the resident engineer.

1. What are your agencies requirements for Independent Assurance testing?

    a. What items are required to be tested and what is the frequency for them?

    b. Where is this testing typically conducted?

    c. What are testing equipment requirements (calibration) and does you agency use nationally adopted standards for testing (AASHTO)?

    d. At what time during the project process this testing is conducted and what is typical turnaround time?

2. What is your agency's standard plan for products that fail the IA testing (dispute resolution)? What type of approach is used to define failure (percent within limits, moving average etc.)?

3. What documentation is generated throughout the process?

Reports go to the FHWA and then decide yearly on what to do.

4. Does your agency use any cored samples from the PCE/PSE element as part of verification testing?

Only in case of investigation. If things go wrong.

5. Does your agency use any non-destructive test procedures for testing of final product (PCE/PSE) prior to compliance or soon thereafter?

6. Does acceptance of the component happen in steps or not?

7. When is the last time the inspector views the component? Does the engineer choose to accept it or not on site?

8. How do you finally accept something?

OVERALL

1. What would you like to see added to the current standard? Removed?

Who is actually in charge? Overseeing job, what are his or her credentials. (Labor perspective)

Material – we have sufficient acceptance testing.

Equipment – for acceptance must be good. Question is you cannot talk about the quality of their forms and beds. Inspect for tolerances.

Standardization: drive prices down. Formwork could be standardized too. Stray from the unique designs

Performance Based Specifications
Allow general contractors to do more pre cast

- Carrera - majority of PS for VTrans
- Dailey – VT
- CSE – NH

Legal regulation associated with inspector's ability to go in and do inspection of the facility.

Shiftplanning

Qualification
Scheduling software

Design Build: no formal process in place.

- Timing synchronization needs to be addressed

	Connecticut	Maine	Massachusetts	New Hampshire - Incomplete	Rhode Island	Vermont
Plant Requirements:						
Plant:	Does not require PCI or NPCA. Requires Plant inspection from CT DOT (Annually)	Must be a PCI Certified facility	PCI/NPCA. Perform their own audit. Audit could be consultant or in house	PCI only. NPCA not required although most plants have it	Plant Cert for Prestressed only - PCI	PCI or NPCA
Office Requirements:	none	List (Hidden cells) Climate Controlled: 68F - 75F Office Area Minimum = 100 square feet Drafting Table Minimum 35 square feet Drafting Stools = 1 Desk = 1 Ergonomic Swivel Chair = 1 Folding Chairs = 2 High=Speed Internet = 1 Fluroescent lighting of 100ft minimum for all working areas = 2 110 volt wall outlets = 3 wall closet = 1 waste basket with trash bags = 1 broom, dustpan = 1 each water cooler = 1 cleaning materials = 1	Audit Checklist on Box (Plant Qualification)	Proper lighting, ventilation, heat (500 3.1.3)	Extensive Checklist on Box	Not Yet Found
Notice of Beginning of Work:		Two weeks for in Maine Three weeks out of state (Maine)		3 days before pour to plan for inspection		Seven Days
Quality Control						
Measurements and Testing:	MNL 116 PS. None for PC	MNL 116 Appendix E	PCI MNL 116	QC Plan not submitted. Must be on hand	PCI MNL 116	PCI MNL 116. PCI MNL 135- Tolerance
Calibration:	annually per MAT 324	MNL 116; Except Stressing Jacks that should be calibrated every 6 months.	calibration done with plant qualification at the beginning	item specific - in specs	PCI MNL 116	Compression machine calibrated yearly by NIST
QCI's Certification:	ACI	PCI Level 1, 2 or 3. Personnel performing concrete testing shall hold a current ACI Field testing Technician Grade 1 or equivalent.	Spec M-4. ACI 1 and 2 possibly others. sufficiently trained and licensed. From M-4 (1988?)	Plant Admin: NETTCP along with PE in NH, EIT with 2 years experience, 3 years highway experience with degree.	Prestressed: NETTCP, PCI, ACI, NICET Precast: none because they do full inspection themselves	PCI Level 1
Reports: The QAI will witness or review documentation, workmanship and testing to assure the work is being performed in accordance with contract documents.	Inspector works alongside QC and they produce documents that can be given to the project engineer if necessary.	Aggregate Gradations (Fine and Coarse) - prior to beginning of work, at least once per week thereafter. Material Certs, Stressing Calcs, Calibration- prior to beginning of work Tensioning - same day Pre-Placement inspection - prior to concrete placement Concrete Batch Slips - morning of the next work day Concrete Testing - morning of the next work day Compressive Strength (release) - same work day Temperature Records - with compressive strength for release NCR's - within 24 hours of discovery Compressive Strength (Design) - prior to stopping curing Post Placement inspection - within 48 hours of achieving design strength		Mix Design: Aggregate source and gradation Concrete supplier and plant location Quality of components stockpile management QC inspection activities QC testing and inspection report forms Process quality control testing: include details for frequency, location, and sampling methods for slump, air, water, temp, and evaporation rate Placement methods: concrete in place time and cons proposed finishing machines evaporation control procedures finishing and curing methods version of spec to be used	Portland Cement: 1 Mill Test Report per source, per lot of cement Reinforcing Steel: 1 mill test report per shipment, per size, per source, per heat number Mineral Admixture: 1 Mill Test Report per truck load of mineral admixture (fly ash, slag, microsilica) Welded Wire: 1 certificate of compliance per source Steel Spec: 1 certificate of compliance per source and mill test report per size, heat number	Complete copy of structural design calculations Dimensions Mix Design: Including but not limited to, batch weights specifying dry or SSD. Material names and sources. Aggregate properties and date tested. chemical and physical properties of cementitious materials admixture names and sources. Lab Data: not limited to Slump, Air Content, Temperature, W/C, Cylinder breaks for 3,7,and 28 days cured in the same manner as the piece. Rapid Chloride Ion permeability test. AASHTO T277 take the average of 3 specimens. ASR from both the fine and coarse aggrgeate If mix design is not previously approved, it shoulld be approved by the Structural Concrete Engineer prior to fabrication. ALL ABOVE SHOULD BE SUBMITTED AS SOON AS PRACTICAL AFTER AWARDING OF THE CONTRACT
QA Inspection and Acceptance Testing						
Responsible:	mostly in house. May have 3 year contracts with consultants. ACI Level 1 or 2	Department: Observe QC; Except some cylinders PC - PCI 1: PS - PCI 2	Consultants: PCI Level 2	Consultants: PCI Level 2	Department: In House. Does not require certification but the department certifies their inspectors.	Department Inspector. In-House or Consultant.
Measurements and Testing:	Only witness plastic tests. No IA because they do not run any tests				Full time inspector performing all tests. Including aggregate and moisture etc. Prestressed: Full time	
NCR's	Notable observation writeup. Then NCR from contractor forwarded to project engineer. Submit repair procedure.	Correct or replace nonconforming material. Generate NCR, provide copy to QAI and forward to engineer for review.	Prepared and submitted to MassDOT and consultant within 24 hours after being	PCI repair plans	Repair plan submitted through the contractor. Typically use PCI or PCA. Usually recast item.	
Forms and Casting Beds	work along QC to inspect pre pour	Accordance with Working Drawings. Inspect the bulkheads after each cast and repair or replace as necessary Remove all paint, adherent material, foreign matter, and debris.	Hold down placement and location, width length depth, block outs location, squareness, rebar placement and size, plates and inserts, lifting loops locations	all aspects inspected (questionnaire)		
Reinforcing Steel	No prescribed frequency. They take steel for testing at central lab every once in a while.	Section 503 of Standard Specs Accurately locate and secure. Install and secure before placement Use minimum cover allowable.	Stressing Strands and Reinforcing Steel: 1 per element from material stockpile strands location, tensioning calcs, pulling of strands, rebar placement and size, at form set up		In Concrete Spec:2 3 foot long samples per size, per source, per year for tension and bend test Steel Spec: 2 3 foot long samples per size, per source, department discretion for mill report comparison Welded Wire: Optional at engineer discretion. 1 24"x24" for coating thickness and wire gauge measurements	Bar Reinforcement: Gr 60 AASHTO M31M/M31. Samples: Where indicated in the contract, 60 inches long submitted to the lab Welded Wire: Grade 75. AASHTO M55M
Voids and Inserts:		Voids should be non-absorbent Out-to-out tolerance of dimensions is 2% of plan dimensions Accurately locate and secure anchor. Recess inserts 1 inch	Plates and inserts location: 1 per element at form set up			
Concrete:		If mix is not previously approved it must follow AASHTO T-126 (ASTM C192)				
Mix Design Requirements:		Mix Design Hidden				
Concrete Placement:	They do not require inpector present for pour however they try to be.	Do not place until all the forms for any continuous placement have been inspected and accepeted by QCI and approved by QAI.				
Testing:		AASHTO or ASTM				AASHTO
Frequency of Testing:	No cylinders required. Follow along with QC and rely on those results after being witnessed by inspector. Testing and frequency dependent on QC	Test first two loads for temp, air, and slump flow for SCC. If first load is unacceptable take second load as first load. Continue until two consecutive loads are acceptable. After two consecutive loads are accepted, the frequency of testing is at the disgression of QAI If there is a change in the dosage rate of any admixture or a change of 5F in mix temperature, then test concrete for temp, air, and slump. Test every load of 1 CY or less from stationary mixer and every load of 2 CY or less from transit mixer for temp, air, slump Test Cylinders: Contractor makes a minimum of 8 for each continuous concrete placement. 2 cured in accordance AASHTO T23 and 6 cured under same conditions as units. Unit ID, air, w/c, slump flow, and temp taken when cylinders are formed. 2 cylinders made for Department, unless permeability requirements then 6 cylinders for department. Tolerance: must exceed or meet design strength, the difference in strength should be no more than 10% of the higher strength cylinder.	Precast Concrete: Air Content, Slump, Temperature, and Compressive Strength 1 test per 150 CY or faction thereof for each pour of each class, minimum of once per day Five 6x12 or 4x8 cylinders Prestressed: Air, slump, temperature, compressive strength, time of set. 1 test per pour Cylinders: Make a minimum of 8 cylinders. 2 for 7-day, 3 for 28-day, and 3 for 56-day. Requirement above is from Scope of Services	Strength, Permeability, Air Content, W/c Ratio, Concrete cover. Concrete cover tested at each data point Lot Size: concrete poured each day or continuous for two to three days Sublot: 0-50 CY - 1 Sublot 50-75 CY - 2 sublots split equally 150-300 CY - 3 sublots split equally Over 300 CY - split evenly between 100-135 CY per sublot	Class X Portland Cement Concrete Cylinders: 4 for less than 100 CY, 6 for over 100 CY per 150 CY for each days production Slump: 1 per 150 CY or each day's production. Air content: 1 per 150 CY or each day's production Portland Cement: One (1) 6 lbs sample per plant per 2 week period randomly sampled and tested every three months Section 808 has similar specs.	Cylinders: 6 for detensioning. 4 for 28 day and shipping strength cured with the piece. Air, Slump, Temperature: at a minimum, the first load and then whenever cylinders are cast. Sample Size = 1 cubic foot for cylinders or wheelbarrow for all tests
Curing:	None that are inspected It should follow MNL 116	Moisture Retention: MNL 116 Accelerated: MNL 116 except as follows: Temp gain must no exceed 40F/hr Initial set determined by ASTM C403 Max allowable temp: 160F Temperature measured at intervals of 100' and at bed ends Minimum temperature of 120F maintained for 8 hours Concrete shall achieve 80% of design strength	Currently working on a spec	Item specific	Prestressed: allow accelerated curing Precast: typically would not use accelerated curing	
Prestressing			MNL 116 (questionnaire)			
Tensioning		MNL 116				PCI MNL 116. PCI MNL 135- Tolerance
Detensioning	Do not have to be present	MNL 116. Measure a minimum of 4 strands per row.				PCI MNL 116. PCI MNL 135- Tolerance
Finishing and Repair		MNL 116 except that the contractor shall rub fascia units in accordance with 502				
Tolerances:		MNL 116				PCI MNL 116. PCI MNL 135- Tolerance
Transportation/Storage	Do not witness loading. Last time witnessed is in the stockyard	Use lifting devices. Handle so that reactions with respect to the unit will be approximate to use. Do not transport until 28 day strength is attained. Support stored precast/prestressed on dunnage.				
Aggregates						
Fine Aggregate:	Sampled each month or as directed by engineer Randomly sampled however plants usually do it themselves	Consist of natural sand or other approved by engineer Tested for organic impurties AASHTO T21 Sand equivalent value of not less than 75 when tested with AASHTO T176 Fineness modulus: 2.26-3.14. Determined using sieve Nos. 4, 6, 16, 30, 50, 100, and diving by 100 Absorption: AASHTO T84 not more than 2.3% Gradation Req Table in Manual	Moisture, sieve analysis, and F.M: 1 per day per plant. 10 lb sample		1 sample per 150 CY for gradation (fineness modulus) 1 50 lbs sample per year for a gradation (fineness modulus) specific gravity, unit weight, and absorption.	Gradation: 1 every other day of production Organic Impurities: 1 @ beginning of job Compressive Strength Mortar: New source Soundness: New source Sample Size: varies, is in table
Coarse Aggregate:	sampled each month or as directed by engineer	Retained on 3/8 sieve no more than 15% ASTM D 4791 using dimensional ratio of 1.5 Absorption: AASHTO T85 no more than 2% AASHTO T327 Micro-Deval less than 18% or not exceed 40% loss by AASHTO T96 Gradation Req in Manual	1 of each size as necessary. 75 lb sample for sieve analysis.		1 sample per 150 CY for gradation 1 150 lbs sample per year for L.A. Abrasion Test, a sodium sulfate soundness, specific gravity, and unit weight	Gradation: 1 every other day of production Percent of wear, Fractured faces, Thin/Elongated pieces, 1 @ beginning of job. Soundness: 1/Source/Year Density (lightweight aggregate): 1 per placement
ASR		AASHTO T303 (ASTM C1260)	AASHTO T303 Modified. For both Coarse and Fine			AASHTO T303
Cementitious Materials	Cement: Qualified source. Samples taken as directed by engineer Admixtures: only qualified admixtures. Samples taken as directed by engineer.		Source control and IA: 12 lb sample, perform relevant tests on cement, silica fume, fly ash, and slag Mill analysis reports furnished with each delivery to concrete plant. Accepted on certificate of compliance and mill test report		1 6 lbs sample per plant per 2 week period randomly sampled and tested every 3 months	Cement, High early portland cement, portland pozzolan cement, blended silica, fume cement, portland blast furnace slag cement: 1 @ beginning of job. Fly Ash, Silica fume, ground granulated blast furnace slag:
Water	each source sampled annually		Only if purity is questionable. Sample size 1 gallon. Relevant tests			
Inspection Cost Range	Senior Technician: Year 1: $47/hr Year 2: $48/hr Year 3: $50/hr		Precast Hourly Range: $71.54-$77.56	45$/hr - 50 $/hr with paid travel time over 1 hr		Approximately $100/hr

PLANT QUALITY CONTROL PERSONNEL

Employee	ACI / PCI Certified	NETTCP Conc. Tech.

Additional remarks ______________________________

____

SOURCE of CEMENT AND POZZOLANS

____

____

____

AGGREGATES AND WATER

Material	Source	Size

SOURCE OF CATCH BASIN FRAMES AND GRATES

____

REINFORCEMENT

Domestic Steel ______________________________

____

Foreign Steel Onsite ______________________________

ADMIXTURES

Manufacturers of Admixtures

Name	Type

Q.C. PLAN DEFICIENCIES

____

____

____

____

PRECAST PLANT QUALIFICATION PROCESS:

Certification: PCI or NPCA certification required:
submit to Matt Sukeforth at matt.sukeforth@state.ma.us

ASR: AASHTO T-303 Modified:
Required for both crse+fine agg; follow instructions in MassDOT 2014 annual letter.

Petrogaphics: ASTM C295:
Required for both crse+fine agg:
submit test results to Matt Sukeforth at matt.sukeforth@state.ma.us

Soundness: AASHTO T-104(sodium sulfate soundness):
Required for both crse+fine agg:
Submit test results to Matt Sukeforth at matt.sukeforth@state.ma.us

Coulomb: AASHTO T-277
Required for HP mixes

Mix Design: 2015 MassDOT mix design sheet: submit to Richard Mulcahy at MassDOT

Trial Batches: Witnessed by MassDOT representative
Cylinder breaks from plant mix need to break at 20% over the 28day design;
If lab trials are performed a break of 30% over the 28day design is required

Plant Inspection: Qualification Audit performed by MassDOT representative. This takes place during trial batches.

A helpful link for the MassDOT annual letter, mix design sheets and qualified products:
http://www.mhd.state.ma.us/default.asp?pgid=research_materials/materials03&sid=about

You may also need to refer to the following publications available from the bottom link:
Standard Specifications for Highway+Bridges(English Edition): 1988
Supplemental Specifications to the Standard Specifications for Highway+Bridges: 6-15-2012
http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/ManualsPublicationsForms.aspx

Please feel free to contact me with any questions.

Matt Sukeforth 617-290-0694

matt.sukeforth@state.ma.us

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION

PRE-CAST/PRE-STRESSED CONCRETE FABRICATION QUALIFICATION AUDIT

Date of Visit: ______________________

Name and Company of Auditor: ______________________

Name and Location of Fabricator: ______________________

Types of Products Produced: ______________________

Number of years in business: ______________________

Number of years experience working for DOT's: ______________________

Floor area used to manufacture products: ______________________

Number of persons employed in production: ______________________

President: ______________________

Plant Manager: ______________________

Quality Control Manager: ______________________

Reports to: ______________________

Years employed in position: ______________________

Years of experience in similar position: ______________________

PCI Certification Number: ______________________

ACI Grade I Certification Number: ______________________

Head of Inspection: ____________________

Reports to: ____________________

Years employed in position: ____________________

Years of experience in similar position: ____________________

PCI Certification Number: ____________________

ACI Grade I Certification Number: ____________________

Supervision ____________________

Supervisors: ____________________

Average number of year's experience: ____________________

Ratio of supervisors to production employees: ____________________

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A. QUALITY SYSTEM	Yes	No	N/A	Remarks
Quality System Manual				
• Does the plant have a written Quality System Manual (QSM)?				
Documented Procedures				
• Does the QSM or Quality Control Plan to document required QC inspection procedures listed in the Precast Specifications or Special Provisions?				
Personnel				
• Are QC individuals in the plant organization certified as a Level II Technician/Inspector in the PCI Quality Control Personnel Certification Program? ACI Concrete Field Testing Technician-Grade I?				
• Does the facility have a training program in place for the training of new QC inspection personnel?				
• Does the facility have a staff of Quality Control (QC) personnel who are separate from production staff?				
• Does the facility have a person responsible for quality who is in charge of the QC personnel and reports directly to management?				
• Does the facility have on file and available, certifications, for all its QC inspection personnel?				
• Were QC personnel available in the plant during this inspection?				
Shop Drawings				
• Does the facility have access to personnel capable of supervising, evaluating, and coordinating shop drawing preparation and/or review?				

• Do the shop drawings for current work indicate materials to be utilized in the fabricated element?				

B. PRODUCTION PRACTICES	Yes	No	N/A	Remarks
Storage of Chemicals, Hardware and Equipment				
• Are chemicals and release agents stored per the manufacturer's recommendations, particularly with regard to temperature extremes?				
• Is steel reinforcement and strand stored on pallets, blocks, racks, or in containers and protected from the elements??????				
Casting Areas				
• Is the casting area of adequate size and supplied with necessary equipment in good operating condition to ensure proper placement, consolidation, and finishing of the concrete?				
Curing and Finishing Areas				
• Is the facility capable of maintaining a minimum concrete temperature of 50° F during the initial curing cycle (prior to stripping)?				
Moist Curing				
• Is the curing area well drained?				
• Is adequate protection/covering provided to maintain the required relative humidity and temperature?				
Accelerated Curing				

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• Does the heat source and distribution system provide uniform and controlled heat?				
• Is equipment provided to record the Time and temperature as necessary during the curing process?				
Finished Product Storage				
• Are storage areas clean, well-drained and stabilized? If outside storage, is product placed on suitable dunnage?				
• Are steps taken to ensure initial cure and minimum compressive strength has been acheived prior to stripping from form and moving product				
Forms				
• Does quality control verify that forms are constructed to conform to the profiles, dimensions, and tolerances indicated by contract documents and approved shop drawings?				
• Is formwork constructed tight to prevent leakage and result in a structure with correct profiles, dimensions, and tolerances?				
• Is formwork kept clean and maintained in a manner consistent with project requirements?				
Product Identification				
• Are precast concrete units clearly marked with a unique identification as shown on shop drawings?				

• Do identifying markings distinguish the date of casting and trace the precast unit to associated quality control records?				
Surface Finishes				
• Does quality control verify that the surfaces of precast concrete units have finishes per shop drawings and project specifications?				
• Are detailed repair procedures provided to personnel?				

C. RAW MATERIALS & ACCESSORIES	Yes	No	N/A	Remarks
Concrete Materials				
• Is documentation available to show fine and coarse aggregate compliance with accepted standards and practices? Gradation Deleterious Substances Soundness Physical Property Requirements				
• Is documentation available to show compliance with AASHTO M85 and who is verifying and documenting the type of cement being delivered?				
• Is documentation available to show flyash compliance with AASHTO M295 and who is verifying and documenting the type of fly ash being delivered? What about ASR??				
• Is documentation available to show admixtures are included on the Qualified Construction Materials list, in compliance with AASHTO M194, and who is verifying and documenting the				

• Are aggregate stored such that they do not get contaminated prior to use, and do they have a hard base with good drainage?				
• Are measures taken to control the moisture content in the aggregates so that it is kept as uniform and stable as practical?				
• Is the water clear and apparently clean? Does questionable water meet the criteria of AASHTO T26?				
• If wash water is reused, does it meet the criteria of AASHTO T26, Table 2?				
• Is the cement and mineral admixture weighed separately from the aggregate and is the discharge controlled so that the cement is flowing while the aggregate is being delivered?				
Reinforcement and Hardware				
• Is documentation available to show steel reinforcing bars are in compliance with specifications?				
• Is documentation available to show that welded wire reinforcement is in compliance with specifications?				
• Is documentation, such as mill certificates, available to show that strand materials are in compliance with specifications? Do they know the strand lots & when to send MassDOT more samples				

D. CONCRETE	Yes	No	N/A	Remarks
Proportioning				
• Has the mix design being used been approved by the engineer of record?				
Batching				
• Has the Batch Plant been certified per NRMCA requirements?				
• Are weight indicating devices in full view and near enough to be read accurately by the operator while charging the hopper?				
• Are exposed fulcrums, devices, and similar working parts of scales clean?				
• Are the scales calibrated and sealed?				
• Are adequate standard test weights available for checking the accuracy of the scales?				
• Are the hopper gates, water and admixture valves, and cement and mineral admixture gates functioning properly and completely stopping discharge?				
• Are proportioning devices certified to meet AASHTO M157 Sec. 9 and Annex A?				
• Are scales zeroed between loads?				
• Is compensation for free moisture in aggregates performed?				
• Do batch tickets record actual quantities, not nominal?				

• Does the operator read the revolution counter, or time the mixing at first addition of water?				
• Does the batch ticket contain the following information? Name of ready mix plant, if applicable Serial number of ticket Date Truck number Name of Purchaser Specific designation of job Amount of concrete in cubic yards Time loaded or first mixing of cement and aggregates				
Mixing				
• Are the mixer blades clean and in good condition?				
• Is the mix design coded or are there other positive means to assure proper mix is delivered?				
• Is documentation available to show that the time from start of concrete mixing to placement does not exceed applicable parameters ?				
Consolidation Equipment				
• Is vibratory equipment operated by trained personnel?				
• Is documentation available to show that vibratory procedures are established at the beginning of each project?				

Curing Concrete				
• Is concrete maintained in an ambient temperature of not less than 50 °F and not greater than 150 °F during the curing prior to reaching stripping strength?				
• Are measures taken to ensure that one portion of the element does not cure differently than another portion?				
• Is documentation available to show that test cylinders are cured in accordance with AASHTO T22?				
• Is documentation available to show that accelerated curing is performed in accordance with ASTM C684? and PCI specifications				
• If elements are cured without supplemental heat, are the surfaces kept covered until the compressive strength reaches the specified strength for transfer or stripping?				
• Are moisture retention enclosures resistant to tearing and positively fastened in place to avoid displacement?				

E. REINFORCEMENT AND PRESTRESSING	Yes	No	N/A	Remarks
Reinforcing Steel				
• Are reinforcing steel deliveries identified with a heat number that can be tied to a mill certificate?				
• Is documentation available to show that fabrication tolerances are in accordance with design requirements?				
• Are reinforcing bars bent cold, unless otherwise permitted by the Engineer?				
• Is damage to galvanized or epoxy coated reinforcing steel repaired using appropriate materials conforming to project requirements?				
• Is documentation available to show that quality control personnel have checked the size, placement, and spacing of all reinforcement against current shop drawings?				
• Are spacers and anchors used to ensure that reinforcement does not shift during placement of concrete?				
• Is documentation available to show that concrete cover and other critical dimensions are measured?				
Tensioning				
• Is documentation available to show that tensioning is performed within stated tolerances and that tensioning operations are subject to quality control procedures?				

• Is documentation available to show that tensioning equipment is calibrated as a system in the same manner used during tensioning operations?				
• Is documentation available to show equipment calibration records which are consistent with calibration requirements?				
• Do calibration records show the following information? Date of calibration Agency, laboratory, or registered engineer supervising the calibration Method of calibration Full range of calibration with gauge readings indicated against actual load				
Pre-tensioning				
• Are pre-stressing steel reels and coiled tendons identified with tags listing the heat number to relate the reel to a mill certificate?				
• Are pre-stressing steel reels and coiled tendons stored in a neat and orderly manner?				
• Is pre-stressing steel stored off the ground and in such a manner as to avoid corrosion?				
• Are tensioning procedures performed by trained and authorized personnel?				

• Do tensioning procedures include the following information: Operation and control of jacking equipment Operation and control of gauging system Tensioning to an initial force and marking strand in preparation for measuring elongation Tensioning to a given final force, measuring,and recording the corresponding elongation Checking for strand anchor seating Procedures in case of out-of-tolerance results Procedures in case of wire failure Alternative tensioning methods or measurements De-tensioning and stripping procedures				
• Are strands positioned in accordance with dimensions shown in current shop drawings?				

F. QUALITY CONTROL	Yes	No	N/A	Remarks
Inspection				
• Is documentation available to show acceptance by quality control personnel of reinforcement and other cast-in items, particularly critical tolerance items?				
• Is documentation available of daily inspection reports of batching, mixing, conveying, placing, compacting, curing, and finishing of concrete?				
• Does documentation exist to show that problems have been reported and have damaged products been recorded, marked, and re-inspected after repair?				
• Does inspection documentation exist to show that finished products are checked against shop drawings, project requirements, and plant standards?				
• Is a final inspection performed of completed products during loading to check for proper blocking, damage, stains, and other problems that may affect the quality of the product?				
Testing and Records				
• Does documentation exist from aggregates suppliers showing that the specific gravity, absorption, and Petrographic analyses have been performed?				
• Does the plant have mill certificates for all reinforcing materials filed ?				
• Are mill certificates filed for each reel or coil of pre-stressing strand or wire in each size?				

• Is certification filed for all steel hardware and insert materials and each different grade of steel?				
• Is documentation available showing that production testing is being performed for aggregates, concrete strength, air content, slump, unit weight, temperature of concrete, air temperature? and all Self Consolidating Concrete test if				
• Are all precast concrete units marked with the date produced and a unique identification number that can be referenced to production, erection drawings, and testing records?				
• Is the following information provided in the tensioning records: Date of tensioning Cast bed identification Description, identification, and number of elements Manufacturer, size, grade, and type of strand used Coil or pack number of strand, identifying number of strands Sequence of stressing Identification of jacking equipment				

• Is the following information documented for pre-tensioning procedures: Required total force per strand Initial force Calculated and actual gauge pressure for each strand or each group of strands stressed in one operation Calculated and actual elongation for each different jacking force Any unanticipated problems encountered during tensioning				
• Does plant have a posted de-tensioning plan, or follow a plan as laid out on approved shop drawings?				
• Are operating instructions, calibration curves, and national and industry standards for all testing equipment maintained on site?				

G. FINDINGS AND ITEMS OF CONCERN

massDOT Highway

DAILY PRECAST/PRESTRESS REPORT

Rev. 5/30/2012

PLANT/LOC.		DATE:	
PROJECT	Town:	Road:	
CONTRACTOR		CONTRACT #	
PRODUCT		COST CODE #	
INSPECTOR		FEDERAL AID #	

REINFORCEMENT	MANUFACTURER	LOCATION	SAMPLE DATE
Rebar Size:			
Rebar Size:			
Rebar Size:			
WWF Sizes:			
WWF Sizes:			
STRAND INFORMATION	MANUFACTURER	LOCATION	N/A
270k lolax Size:	N/A		N/A
LOT#	COIL#s		

PREPOUR INSPECTION

FORM		CLEAN/OIL		VOIDS/SLEEVES	
INSERT		STRANDS	N/A	HOOKS/ANCHORS	
REBAR		SHAPE		POSITION	

AGGREGATE/CEMENT SUPPLIERS

MATERIAL	COMPANY	LOCATION	SAMPLE DATE
SAND			
STONE			
CEMENT			
SLAG			
ADDITIVES			N/A

CONCRETE MIX PSI SPEC: 5000psi

MATERIAL	SAND	STONE	CEMENT	SLAG	FLY ASH	S. F.	dci cni	AEA	HRWR	H2O
DESIGN										
ACTUAL										
% MOISTURE										

	SLUMP	FLOW	% AIR	TEMP	U.W. CYLINDER RELEASE STRENGTH
SPECS.	7 1/2 max		4.5 to 7.5	60-90	
TEST #1					
TEST #2 (Cyls)					

CAST INFORMATION

# of UNITS		ID MARK			
START TIME		END TIME			
HEAT @	P.M.	MAX TEMP		# HOURS	

REMINDER: Cement and Flyash/Slag batched weights must be zero to plus 4% of design weights.

REMINDER: Aggregate batched weights must be within plus or minus 2% of design weights.

REMINDER: If appropriate please attach stressing and heat temperature reports.

REMARKS:

INSPECTOR SIGNATURE:

MassDOT Highway

INDEPENDENT ASSURANCE REPORT FOR CEMENT CONCRETE

Rev. 8/20/2012

PROJECT INFORMATION

Project Location:		Contract No.:	
Contractor:		Federal Aid. No.:	
Report to District:	R+M	Cost Account No.:	

PLANT INFORMATION

Concrete Producer:		Location:	
Type of Mix:			

SAMPLING INFORMATION

Date & Time Sampled:		Sampling Location:	
Lot No.:		Sub Lot No.:	
IA Project Quantity:		District IA or QC IA?:	
District IA Report No.:		QC IA Report No.:	
District IA's Required:		QC IA's Required:	

TRUCK INFORMATION

Truck No.:		Load No.:		Counter:		Cap / Plate:	
Arrival Time:		Departure Time:		Batch / Time:			

PUMP INFORMATION

Company:				Location:			
Capacity:		Horiz. Travel		Vertical Travel:		Diameter:	

TEST EQUIPMENT INFORMATION

Air Meter / Type:		Condition:		Calibration Date:		Mallet:	
Scoop:		Rod:		Slump Cone:		Condition:	
Base:		Rod:		Ruler:		Tub:	
Pan:		Wheelbarrow:		Shovel:		Thermometer:	

CURING INFORMATION

Box & Cover:		Seal:		Condition:		Air/Water (°F):	
Water Level:		Heat Control:		Thermometer:		Box Level:	

TEST RESULTS

TEST	LAYERS	ROD	TAP	COVER	DISTRICT / QC	R&M	TOL.
TEMPERATURE (F)							2 F
SLUMP (in.)							1"
AIR CONTENT (%)							0.5%
CYLINDER							
7 DAY - C1 (PSI)							
28 DAY - C1 (PSI)							
28 DAY - C2 (PSI)							
28 DAY AVG. (PSI)							15%

REMARKS

RESIDENT ENGINEER & DISTRICT FIELD INSPECTOR SIGNATURES

Resident Engineer:		Dist. Field Inspector:	
Signature:		Signature:	
Date:		Date:	

RESEARCH & MATERIALS REVIEW & SIGNATURES

Results are within tolerances:		Results are not within tolerances:	
R&M Inspector:	SUKEFORTH R+M	Reviewed by:	
Signature:		Signature:	
Date:		Date:	

RHODE ISLAND DEPARTMENT OF TRANSPORTATION
MATERIALS SECTION
ANNUAL PRECAST/PRESTRESS CONCRETE PLANT LAB EVALUATION

Plant: ______________________ **Date:** ______________________

Location: ______________________ **Inspected By:** ______________________

Contact: ______________________ **Mailing Address** ______________________

e-mail:

	Section 930 - Plant Field Laboratory Requirements	Initial Inspection	Final Inspection	Comments, Condition, Calibration, Etc.
	930.02.1 Location			
1	Lab shall be located in its own building.			
2	Lab shall be in sight distance of plant and sampling rack. An unobstructed line of sight shall be maintained at all times			
	930.02.2 Construction			
3	Min. lab dimensions **200** SF with 7.5' ceiling			
4	Sturdy and level Concrete floor			
5	Watertight building			
6	(2) Standard Windows min. equipped with shades and screens			
7	(2) Doors with adequate locks. At least 1 door shall open to the external environment when located on external wall.			
	930.02.3 Other Requirements			
8	(b.) Water, fuel, and electrical power supplied to conduct various tests			
	930.02.4 ADA Considerations			
9	**Is Lab ADA Compliant?**			
	930.03.1 Interior Utilities			
10	(a.) Power provided shall be adequate to simultaneously operate all lab and office equipment, heating and air conditioning, lights and all other utilities			
11	(b.) Heating and Air Conditioning capable of maintainining year round temperature between **68°F - 78°F with controls in lab**.			
12	**(**c.) Restroom facilities **to include toilet, lavatory sink, slop sink, vent fan and running hot and cold water with 5-Gal. min. water heater tank**			
13	**(c.) Restroom shall be fully equipped and located in lab or existing building and accessible at all times during production.**			
14	**(d.) Adequate and satisfactory lighting per OSHA 1926.56 - 10 foot-candles min.**			
15	(e.) (1) Telephone handset **and answering machine.**			

930.03.2 Outside Facilities				
16	**(a.) Parking area for 2 vehicles adjacent to lab building**			
17	**(a.) Parking area shall be paved or well-compacted crushed gravel with maintained surface characteristics**			
18	**(b.) Adequate outside lighting for bins, stockpiles, sampling racks, laboratory access, and parking area per OSHA Standard 1926.56 5 foot-candles min.**			
19	(c.) Lab building shall have locking doors and windows			
20	**(d.) Bins for coarse and fine aggregates shall be safe and accessible for sampling**			
930.03.3 Furninshings, Equipment and Supplies				
21	(a.) (1) Office Desk **30"H, 32"x60"** desk top **with 2 or more drawers each side**			
22	(b.) (1) Work table or bench			
23	**(c.) (2) Swivel desk chairs**			
24	(d.) (1) Fireproof filing cabinet w/lock			
25	**(e.) A cabinet or closet with lock**			
26	**(f.) (1) Wastebasket**			
27	**(g.) A cooling fan**			
28	(h.) A hood with exhaust fan or dust eater near the scales			
29	**(i.) A copy machine with paper and toner**			
30	**(j.) A minimum 4.0 CF refrigerator**			
31	**(k.) Microwave oven**			
32	(l.) (1) Water cooler and fresh drinking water or supply of bottled drinking water restocked as necessary			
33	**(m.) Clock**			
34	**(n.) Calculator - desk size**			
35	(o.) (1) 1st-Aid kit fully stocked			
36	(p.) (1) Fire extinguisher			
37	**(q.) Cleaning supplies for lab and lavatory to be restocked as necessary**			
38	**(r.) Shop vacuum**			
39	**(s.) Toilet paper holders, paper towel dispensers, soap dispensers in lavatory**			
40	**(t.) Rugs with non-slip backing for all doors 2'x3' minimum**			
930.03.4 Computer Equipment				
41	Computer per Special Provision 930.100			

930.03.5 Maintenance and Custodial Service				
42	(a.) Contractor shall properly maintain equipment and keep in working condition and replace supplies as needed			
43	**(b.) Custodial services to include weekly trash removal, weekly restroom cleaning, bi-weekly floor cleaning and bi-monthly window cleaning**			
44	Lab is for exclusive use of state during all production. Laboratory equipment shall remain clean and functional at all times.			
930.04.2 Cement Concrete Mixing Plants Special Requirements				
45	**(a.) Access to the lab must be provided at least 2 hours before production begins**			
46	1. (1) Digital platform beam scale, capacity 45kg (100 lbs) ± 5 g (± 0.01 lbs) Calibrated at 6-month intervals.			Calibration Date:
47	*2. (1) Two-burner electric hot plate. UL approved			
48	*3. (1) Gravity drying oven. Rugged construction w/ 3/8" insulated walls, 2 expanded metal shelves, automatic thermostat and other controls, glass thermometer 0°C - 300°C ± 1°C. Dimensions 18"W X 14"D X 19"H min.			
49	* Or a conventional household stove/oven w/ oven thermometer			
50	4. (1) Sieve shaker with built in timer w/ 8 changeable screens and hydraulic clamping system. Set on 1' concrete pad, enclosed, covered and with adequate ventilation. To include the following US Standard tolerance screens:			
51	1"			
52	3/4"			
53	1/2"			
54	3/8"			
55	#4			
56	#8			
57	#16			
58	Pan			
59	5. (1) Motor-driven portable sieve shaker operated on 110-volt, 60 cycle single phase current w/belt driven mechanism to produce rocking and tapping action. Mounted on sturdy base. Capacity for 6 full height sieves plus pan and cover.			

60	6. Brass frame U.S. standard testing sieves full height, 8" diameter and matched for nesting as follows (1 each):			
61	3/4"			
62	1/2"			
63	3/8"			
64	#4			
65	#8			
66	#16			
67	#30			
68	#50			
69	#100 (2)			
70	#200 with No. 14 mesh backing			
71	Pan (2)			
72	Cover			
73	7. (2) Fine 2" sieve or sash brushes			
74	(2) Brass wire briquette brushes			
75	8. (8) Steel pans (10" x 14" x 2 1/4")			
76	9. (1) Air meter test outfit, AASHTO T-152 & ASTM C-231. To include: 1/4 CF measuring bowl and cover, 16"L X 5/8" dia. steel tamping rod (hemispherical tip), 1.25 ± .5 lb rubber mallet, strike off bar, strike off plate, water bottle/syringe			
77	10. Slump test outfit, AASHTO T23 and T119. To include: slump test mold, 16"L X 5/8" dia. steel tamping rod (hemispherical tip), measuring device, ± 1/4", pan (24" X 24" X 3") steel with reinforced rims			
78	**11. Sample splitter - 16 chutes 1/2"W			
79	**12. Sample splitter - 8 chutes 2 1/2"W			
80	** OR adjustable sample splitter			
81	13. (1) Digital scale. Capacity 2000g ± 1g Calibrated at 6 month intervals.			Calibration Date:
82	14. (1) #1 small concrete scoop			
83	15. (2) Dial thermometers 0°F - 160°F			
84	16. (4) Buckets, plastic, 5-Gal. capacity			
85	**17. (1) Long handle spade shovels**			
86	28. (1) Steel brush, long handle			
87	19. (2) Putty knives			
88	20. (2) Pairs suede work gloves			
89	21. (1) Square steel trowel, 6" length center handle			
90	22. (1) Plastic storage tote (10 Gal. capacity, 24" X 16" X 8.75" minimum) or acceptable equivalent			
91	23. (1) Large concrete scoop #2			
92	**24. (1) Square shovel**			
93	**25. Table or bench to run air test and fabricate cylinders on**			
94	Compressive Strength Testing Machine, calibrated every 6 months			Calibration Date:
95	Disposable dust masks			
96	(2) Safety glasses			
97	Are bins adequately separated?			
98	Are facilities safe, suitable for obtaining and storing aggregate samples?			
99	Are stockpiles adequately separated?			
100	Cement and aggregate scales & water meters calibrated at 60 day intervals			Calibration Date:
101	Mixer trucks must have functional revolution counters			
102	Mixes submitted 60 days prior to production?			

controls shall be locked and sealed during operation. Changes in selector controls or weight settings shall not be made without authorization. Provisions shall be made to vary the size of the batch without affecting the proportions of the design mix.

3.1.2.2.2 All batch equipment in automatic plants shall be interlocked to prevent the discharge of any ingredient into the system until all batching controls have been cleared of the previous batch and the discharge gates and supply valves are closed.

3.1.2.2.3 A moisture meter equipped with automatic adjustable compensating controls shall be installed to accurately and continuously measure the moisture content of the fine aggregate. The moisture compensating dial shall automatically adjust the amount of batch water added and the batch weight of the fine aggregate consistent with the variations of free moisture in the fine aggregate.

3.1.2.2.4 If the automatic proportioning devices become inoperable or malfunction during a concrete placement, the plant may operate manually for the completion of the pour. If the breakdown is readily correctable or is due to a condition within the producer's control, the plant will not be permitted to operate. If unavailability of parts or service or any condition beyond the producer's control exists, written permission may be given to operate the plant manually for a specified period. Accuracy shall be maintained as specified in 3.1.1.

3.1.3 Testing Equipment and Facilities.

3.1.3.1 Method Requirements.

3.1.3.1.1 The necessary equipment as specified and ordered shall be provided at all batch plants. Approved enclosed space for the use of the Engineer for storage and use of the testing equipment shall be provided including proper lighting, ventilation, and heat. The equipment shall include the following:

(a) Set of 8 in. (200 mm) brass sieves, full height- 2 in. (50 mm), sizes 3/8 in., Nos. 4, 8, 16, 30, 50, 100, 200, (9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 0.600 mm, 0.300 mm, 0.150 mm, 0.075 mm) with pan and cover.
(b) Motor driven shaker for 8-inch (200 mm) sieves.
(c) Scale, 2 000 grams capacity, 0.1 gram sensitivity.
(d) Approved motor drive mechanical shaker, tray size 18 by 26 in. (460 by 660 mm), 2-1/3 ft^2 (0.2 m^2); screen sizes 1-1/2 in., 1 in., 3/4 in., 1/2 in., 3/8 in., No. 4 and No. 8 (37.5 mm, 25.0 mm, 19.0 mm, 12.5 mm, 9.5 mm, 4.75 mm, and 2.36 mm).
(e) Field scale, 70 lb (40 kg) capacity, and 0.1 lb (0.1 kg) sensitivity.
(f) Drying equipment, hot plate or oven with tins.
(g) Speedy Moisture Tester, 26-gram size. If approved electronic probes are used, the Speedy Moisture Tester requirement may be waived.
(h) Sample splitter (riffle type).

3.1.3.1.2 The following test equipment shall be furnished on all projects calling for 10 yd^3 (7.5 m^3) or greater of concrete unless specifically waived:

(a) Slump test set, (AASHTO T 119)
(b) Air-Entrainment Meter (AASHTO T 152, Type B)
(c) Curing box for concrete cylinders*
(d) Scoop and squared trowel, minimum 6 in. (150 mm) blade.
On projects with more than 100 CY (75 m3) of concrete, the following additional test equipment will also be required:
(e) Scale, minimum 70 lb (40 kg) capacity, 0.1 lb (0.1 kg) sensitivity
(f) Steel "Contractor's" wheelbarrow
(g) Hoe and hand shovel
(h) Ten foot (three meter) metal straightedge
(i) Microwave oven, 700 watt, 120 volt, 60 hertz, minimum 1.3 ft3 (0.04 m3), variable power from 10 to 100 percent.
(j) A scale, minimum capacity of weighing a 5 kilogram sample, 1.0 gram sensitivity.

* On projects with less than a total of 100 yd^3 (75 m^3) of concrete, the curing box shall be relatively airtight with provisions for storing cylinders in damp sand or sawdust at temperatures between 60º F (16º C) and 80º F (27º C). On projects with more than 100 yd^3 (75 m^3) of concrete, the curing box shall comply with the following specifications:

The internal dimensions shall be approximately 30 in. long by 18 in. wide by 19 in. deep (760 mm long by 460 mm wide by 480 mm deep). The top shall be hinged at the back and a lock shall be provided at the front. The interior shall be rustproof. A moisture-proof seal shall be provided between the lid and the box.

A drain pipe shall be provided through the side of the box. A grating shall be provided to hold the concrete cylinders above the water surface.

A minimum/maximum thermometer shall be installed to measure the internal temperature of the box. The thermometer shall be readable from outside of the box and shall be accurate to within 2 °F (1 °C). The thermometer shall have minimum graduations of 2 °F (1 °C). A thermostat shall maintain the water at a temperature of 72 ± 5 °F (22 ± 3 °C) when the ambient temperature is as low as -10 °F (-23 °C).

3.1.3.1.3 When concrete is placed at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.

3.1.3.1.4 Testing equipment shall be calibrated by the Contractor in accordance with 106.03.

3.1.3.2 Performance Requirements (QC/QA)

3.1.3.2.1 The following test equipment shall be furnished on all projects calling for 10 yd^3 (7.5 m^3) or greater of concrete unless specifically waived:

(a) Slump test set, (AASHTO T 119)
(b) 2 Air-Entrainment Meters (AASHTO T 152, Type B)
(c) Curing box for concrete cylinders
Provide a sufficient number of boxes to hold all the required number of concrete test cylinders for a minimum period of 48 hours.
(d) Scoop and squared trowel, minimum 6 in. (150 mm) blade.
On projects with more than 100 yd^3 (75 m^3) of concrete, the following additional test equipment will also be required:
(e) Scale, minimum 70 lb (40 kg) capacity, 0.1 lb (0.1 kg) sensitivity
(f) Steel “Contractor’s” wheelbarrow
(g) Hoe and hand shovel
(h) Ten foot (three meter) metal straightedge
(i) Microwave oven, 700 watt, 120 volt, 60 hertz, minimum 1.3 ft^3 (0.04 m^3), variable power from 10 to 100 percent. (Provide 2 for QC/QA)
(j) A scale, minimum capacity of weighing a 5 kilogram sample, 1.0 gram sensitivity.
(k) Sufficient number of microwave safe dishes.

3.1.3.2.3 When concrete is placed at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.

3.1.3.2.4 Testing equipment shall be calibrated by the Contractor in accordance with 106.03.3.1.4 Consistency.

3.1.4.1 Method Requirements

3.1.4.1.2 Mortar proportions shall be kept to the lowest that will provide the desired workability. Mixing water shall be kept to the minimum that will produce the required consistency as measured in accordance with AASHTO T 119, as modified in 3.1.6, and does not exceed the water/cement ratio established by Table 1A unless authorized by the Engineer. Slumps shall be kept within the following limits unless otherwise permitted:

Rec'd 5/23/15 [illegible]

NPP Northeast Prestressed Products, LLC Precast Concrete Technology

Pre-Pour Checklist

PCI CERTIFIED PLANT

Contractor: Milton C. Beebe   Mansfield CT.   Bed# 4   Date: 5/23/15

Job/Pour# 14055-7   North Hillside Road   Beam Type: 39" Box Beam

Beam #	S1-G1-7					
Bulkheads	G					
Strand Pattern	G					
Debonding	G					
DAPS	/					
Embed Plates	/					
Skew/Batter	G					
Forms	G					
Beam Length (+/- variance)	W) 81' – 2 5/8" E) 81' – 2 5/8"	W) E)	W) E)	W) E)	W) E)	W) E)
Non-bearing Area	G					
ID Plate	G					
End Steel	G					
Bottoms	G					
Diaphragm Inserts	G					
Diaphragm/Bracing Holes	/					
Dowel Bar Splicers	/					
Forming Inserts	G					
Utility Inserts	G					
Reinforcement Inserts	G					
TV Bolts/ Anchor. Blockouts	/					
Dowels	/					
Drip Notch	/					
End Proj. Strand/ Moment Steel	/					
Lifters	/					
Stacking Detail	G					

NPP (F-010)
7/2014

Rec'd 5/27/15

Tensioning Report

NPP Northeast Prestressed Products, LLC Precast Concrete Technology

Contractor: Beebe

State Abbreviation: CT

Date: 5/22/2015

Span: 1 Beam #: S1-G1

Time: 7:15 PM

0 0

Bed # : 4

Conc Set Temp: 81

Amb Temp: 76

Temp Diff: 5

Pump # : 2

Initial Load: 4,000 # Strand: 40

Ram # : 400 A

Strand size: 0.6

Job # : 14055-7

Total Elongation: 8 3/16"

Gauge Reading:	Actual	Adjusted
1	3,950	3903
2	3,950	3911
3	4,000	3950
4	3,900	3817
Full Tension:	15800	15581

Load Cell: 1) N/A

2) N/A

Elongation at Dead End:

10' N/A

20' N/A

Slippage: Live end-- 1/8" Dead End-- 1/8" Each End of Splice Chuck-- N/A

(strands are marked with paint to verify slippage)

Number of Broken Wires------- NONE

Strand Brand Used--- Insteel 0.6 0.6 270 K Low Relaxation

Reel No.--				
1203405600290	120340560227	1201405117107	0	0
0	0	0	0	0
0	0	0	0	0

Strand Brand Used---

Reel No.--

Shorts Brand Used---

Reel No.--

Tension By: Ron Stancavage

Checked By:

Inspector:

Rec'd 5/27/15 EHJ

Date: 5/23/2015

State Project No. 77-215 Bed # 4

Contractor: Milton C. Beebe & Sons

Job # 14055-7

NPP Northeast Prestressed Products, LLC Precast Concrete Technology

Town of Mansfield

Operator: SG/RB

Release: 6,000 psi

56-Day: 8,000 psi

Cement: Lehigh type 3

Mix: 14-CDH30

150.37 Conn Dot

NPP Pour Sheets

Beam Marks	Time	Ambient Temp.	Amp. Reading	Concrete Temp.	Water	Slump	Air Content	Cubic Yards	MasterAir AE 90	MasterSet R 100	MasterGlenium 7710	Curing Duration	Cylinder #	Concrete Strength	Page 1 of 1 Silo # 1 ; Remarks:
S1-G1-7	5:46				40 / 42	9"	8.8	2	16	27	132	3 Day	57		144.4
	6:26	54°	225	70°	/ 77	8"	6.4	4	23	52	264	3 Day	58		150.0
	7:05				33 / 34			1 3/4	10	24	115		59		+20
	7:41		220		77 / 77			4	23	52	264		60		Silo 3
	7:54		230		76 / 77			4	23.25	53	264		61		
	8:06		228		76 / 78	5 1/4"	5.0	4	23	52	265		62		151.6
	8:21		206		/ 78			4	23	52	265	56 Day	63		+20 oz
												56 Day	64		
											Total 23 3/4				
											bb	2			
															2 BB outside
															0 yd waste

massDOT Highway

DAILY PRECAST/PRESTRESS REPORT

Rev. 5/30/2012

PLANT/LOC.		DATE:
PROJECT Town:	Road:	
CONTRACTOR		CONTRACT #
PRODUCT		COST CODE #
INSPECTOR		FEDERAL AID #

REINFORCEMENT	MANUFACTURER	LOCATION	SAMPLE DATE
Rebar Size:			
Rebar Size:			
Rebar Size:			
WWF Sizes:			
WWF Sizes:			
STRAND INFORMATION	MANUFACTURER	LOCATION	N/A
270k lolax Size:	N/A		N/A
LOT#	COIL#s		

PREPOUR INSPECTION

FORM		CLEAN/OIL		VOIDS/SLEEVES	
INSERT		STRANDS	N/A	HOOKS/ANCHORS	
REBAR		SHAPE		POSITION	

AGGREGATE/CEMENT SUPPLIERS

MATERIAL	COMPANY	LOCATION	SAMPLE DATE
SAND			
STONE			
CEMENT			
SLAG			
ADDITIVES			N/A

CONCRETE MIX PSI SPEC: 5000psi

MATERIAL	SAND	STONE	CEMENT	SLAG	FLY ASH	S. F.	dci cni	AEA	HRWR	H2O
DESIGN										
ACTUAL										
% MOISTURE										

	SLUMP	FLOW	% AIR	TEMP	U.W. CYLINDER RELEASE STRENGTH
SPECS.	7 1/2 max		4.5 to 7.5	60-90	
TEST #1					
TEST #2 (Cyls)					

CAST INFORMATION

# of UNITS		ID MARK			
START TIME		END TIME			
HEAT @	P.M.	MAX TEMP		# HOURS	

REMINDER: Cement and Flyash/Slag batched weights must be zero to plus 4% of design weights.

REMINDER: Aggregate batched weights must be within plus or minus 2% of design weights.

REMINDER: If appropriate please attach stressing and heat temperature reports.

REMARKS:

INSPECTOR SIGNATURE:

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
BUREAU OF MATERIALS & RESEARCH

PRECAST/PRESTRESSED PREPLACEMENT CHECKLIST

PROJECT NAME: NUMBER:	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.
PRODUCER:							
PLACEMENT DATE							
REBAR (SIZE & No.)							
BED OR FORM I.D.							
REBAR CLEARANCE							
STRAND PATTERN							
ALIGNMENT							
REBAR GRADE							
END DETAILS							
PLATES							
BLOCKOUTS							
CHAMFER STRIPS							
DIMENSIONS (OVERALL)							
LENGTH							
WIDTH							
DEPTH							
PLUMBNESS (FORM)							
SQUARNESS (FORM)							
GENERAL APPEARANCE							
CLEANLINESS							
TIGHTNESS OF FORMS							
BRACING OF FORMS							

VIBRATORS: ______________________________

METHOD OF PLACEMENT: ______________________________

COMMENTS: ______________________________

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
BUREAU OF MATERIALS & RESEARCH

PRECAST/PRESTRESSED POSTPLACEMENT CHECKLIST

PROJECT NAME: NUMBER:	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.	PIECE I.D.
PRODUCER:									
PLACEMENT DATE									
POST PLACEMENT INSPECTION DATE									
STRIPPING BREAKS									
PIECE DIMENSIONS									
INSERT LOCATIONS & DIMENSIONS									
CHAMFER STRIPS									
CRACKS EXTENDING TO REINFORCEMENT									
ROCK POCKETS OR HONEYCOMBING									
EDGE OR CORNER BREAKAGE									
PRESENCE OF DAMAGED ENDS									
FINE HAIR CRACKS OR CHECKS									
STRAND SLIPPAGE									
SQUARENESS									
MEASURED CAMBER									
SURFACE APPEARANCE									
BLOCKOUTS									
INSERTS									
STORAGE LOCATION									
DUNNAGE LOCATION									

COMMENTS:

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
BUREAU OF MATERIALS & RESEARCH

PRESTRESSED TENSIONING CHECKLIST

PROJECT NAME:	JACK I.D.:
NUMBER:	STRAND (size, type & heat No.):
PRODUCER:	INITIAL TENSION:
DATE OF TENSIONING:	FINAL TENSION:
BED I.D.:	TARGET ELONGATION:
PIECE Nos.:	UPPER ELONG. LIMIT:
TOTAL NUMBER OF STRANDS:	LOWER ELONG. LIMIT:

Tensioning Order	Strand Number	Measured Elongation	Acceptable (y/n)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Tensioning Order	Strand Number	Measured Elongation	Acceptable (y/n)
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			

COMMENTS:

NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
BUREAU OF MATERIALS & RESEARCH

PRESTRESSED STRAND LOCATIONS

PLOT STRANDS ON GRID

23																								
22																								
21																								
20																								
19																								
18																								
17																								
16																								
15																								
14																								
13																								
12																								
11																								
10																								
9																								
8																								
7																								
6																								
5																								
4																								
3																								
2																								
1																								
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X

COMMENTS:

RHODE ISLAND DEPARTMENT OF TRANSPORTATION
MATERIALS AND QUALITY ASSURANCE
PRECAST / PRESTRESSED CONCRETE - DAILY INSPECTION REPORT

Counter No: ________

Date: ____________

Producer: ______________________ Plant Location: ______________________

Mix No: ______________________ Mix Class: ______________________

Cast No: __________ Date Cast: __________

Contract No	**Products**	**Tag ID**	**Quantity**

		SPEC	**RESULTS**			
Air Content (%):			1	2	3	4
Slump / Spread (in.):			1	2	3	4
Temperature (°F):	**Concrete**		1	2	3	4
	Ambient		1	2	3	4
Unit Wt (lb/cu ft):			1	2	3	4

Cylinders Cast: **4 x 8"** ☐ **6 x 12"** ☐ **No of Cyl:** ______

Release Breaks (psi):	1	2	3	4

- ☐ **Pre-Pour Inspection**
- ☐ **Full QA Inspection**
- ☐ **Compressive Strength Release**
- ☐ **Release of Structures**

Comments: ____

____

____

____

Plant Inspector (Print / Sign) Date

Terminology	Definitions
Acceptance Program	A thorough and consistent evaluation of all factors that are to be used by the Owner to determine the quality and acceptability of the product or work as specified in the contract requirements. These factors include, but are not necessarily limited to, material certifications, acceptance sampling and testing and inspection.
Acceptance Sampling and Testing	Sampling, testing, and the assessment of test results to determine the quality of produced material or construction is acceptable, in terms of the specifications.
Agency Laboratory	An Agency owned laboratory other than the central laboratory where acceptance samples are processed by Agency personnel or representatives.
Accredited Laboratory	It is a laboratory that is accredited by the AASHTO Material Reference Laboratory (AASHTO re:source).
Consultant Laboratory	An Independent Laboratory in which independent and qualified personnel process acceptance samples.
Central Laboratory	The Agency's primary laboratory.
Certified Personnel	Any person determined qualified by an appropriate certification program, as determined by the Owner.
rification and Resolution of Material Test Resu	The procedure used to resolve disagreements between the Owner and its Contractor regarding material quality and material test results.
Confirmation	The act of determining whether the product supplied matches the product identified in the material certification submitted.
Contractor	The individual, partnership, firm, corporation, any acceptable combination thereof, or a joint venture which is a party to the Contract with the Owner which is undertaking the performance of the work under the terms of the Contract and acting directly or through its agent(s) or employee(s). The term "Contractor" means the prime Contractor as differentiated from a Subcontractor.
Contractor Laboratory	A laboratory which may be owned and/or operated by a Producer or Contractor. This laboratory may be located on a construction site for the purpose of processing Acceptance or quality control samples.
Fabricator or Producer	A company that produces or fabricates materials for use on a specific project (i.e. Aggregate, Hot Mix Asphalt (HMA), Portland Cement Concrete (PCC), Precast/Prestressed Concrete) by either the Contractor or Subcontractor.
Independent Assurance (IA) Comparison	The act of evaluating the variation between the Acceptance and IA test results. The results of a comparison are documented in an IA Comparison Report.
dependent Assurance (IA) Sampling and Testin	Sampling and testing that is conducted by the Certifications and Independent Assurance (C&IA) Unit of the Materials & Research Section to provide an unbiased and independent evaluation of the Acceptance Program.
Independent Assurance (IA) Program	Unbiased activities that are performed by certified personnel that are not directly responsible for quality control or acceptance. These activities provide for an independent assessment of equipment, and evaluation of the sampling and testing methods employed during the Acceptance Program to ensure conformance with established procedures. Test procedures used in the Acceptance Program performed at the central laboratory are exempt from this program. Test results of IA tests are not to be used as basis of material acceptance.
Lot	A defined quantity of material from a single source assumed to be produced and/or placed essentially by the same controlled process.
Manufacturer	A company that manufactures and supplies standard manufactured materials or fabricated materials for use on a project.
Material Certifications	Documents submitted pursuant to Subsection 700.02 of the Agency's "Standard Specifications for Construction" by the Manufacturer or Producer of a product that assures (or certifies) that the product used in the work conforms to all applicable requirements of the Owner's standard specifications, drawings, and contract provisions for the intended project.
National Highway System	The National Highway System (NHS) includes the Interstate Highway System as well as other roads important to the nation's economy, defense, and mobility. The NHS was developed by the United States Department of Transportation (USDOT) in cooperation with the states, local officials, and metropolitan planning organizations (MPOs).
Non-Strucural Concrete Elements	Non-structural concrete is concrete that has a low strength and will be used when only small compression or temporary loading is involved.
Population	All of the specimens obtained from a lot that are used to represent the entire lot of material.

Qualified Laboratory	A non-accredited, Owner approved laboratory that provides test results used to determine acceptance.
Qualified Personnel	Personnel that have successfully completed the Agency’s Qualified Technician Program or an Owner approved qualified technician program.
Quality Assurance Program	Documented, predicted, and systematic actions conducted to provide sufficient confidence that a product or service will satisfy given or specified requirements. For example, it identifies the various elements of the Owner’s sampling, testing and inspection programs that are in place to assure that the materials and workmanship incorporated into the Owner’s construction projects are in conformity with the requirements of the approved plans and specifications including approved changes.
Quality Characteristics	The specific material properties evaluated by quality control and acceptance sampling and testing.
Quality Control	All activities performed by the Contractor, Producer, and Manufacturer in the manufacturing, production, transport and placement to ensure the materials incorporated and work performed on a project meet or exceed contract specification requirements. These activities include material handling, construction/manufacturing procedures, calibration and maintenance of equipment, production process
Quality Control Plan	A detailed document prepared by the Contractor or Producer identifying the processes to ensure the quality of material.
Referee Sample	A split or replicate sample that is taken, prepared and stored in an agreed upon manner for the purpose of settling a dispute.
Replicate Samples	Two or more material samples taken at the same location and time. These samples are taken to estimate sampling and testing variability.
Split Sample	A split sample is a single material sample that has been divided into two or more portions. These samples are taken to estimate testing variability.
Standard Manufactured Materials	These are items produced routinely (i.e. not for a specific project) by a Manufacturer.
Subcontractor	An individual or legal entity to whom or which the Contractor sublets part of the work.
Strctural Concrete Elements	A structural element is a member or part of a building, e.g. a beam, column, wall or floor slab, designed to carry loads of various kinds imposed upon it. The element is usually subjected to bending or direct forces or a combination of these.
Standard Manufactured Materials	These are items produced routinely (i.e. not for a specific project) by a Manufacturer.
Validation	The process of comparing two independently obtained sets of test results to determine whether they came from the same population.

Prestressed Elements

Inspection Criteria	Recommendations	Remarks
Pre-Pour		
Calibrations		
Cement Scales Aggregate Scales	Date of Last Calibration. Ensure that calibration was done once every 12 months or 75000 CY concrete production which comes first.	
Water Meter		
Stressing Jack and Gauges	Date of Last Calibration. Once per year or in case of any erratic result.	
Cylinder Compression Tester	Date of Last Calibration. Ensure that calibration was done once per year.	
Producer's Air Meter	Date of Last Calibration. Ensure that calibration was done within last three months.	
Sequence of Concrete Placement	Once per each design/element type	
Pre-Stressing Strand		
Domestic Origin	Yes or No	
Coil Identification	ID #	
Cross Sectional Area	Cross Section (square inches)	
M.O.E	Check QC Technician's provided data and document	
Stressing Calculations	Check QC Technician's provided data and document	
Size (diameter)	Strand diameter	
Strand and Other Reinforcement Pattern	Ensure that strands and other reinforcement is according to the design plan (hold down- hold up locations). Copy strand	
Lateral Location	Check QC Technician's provided data and document	
Vertical Location	Check QC Technician's provided data and documents	
Clean of Contaminants	Yes or No	
Elongations	Check QC Technician's provided data and document	
Strand Temperature	If temperature deviates from 70°F, then temperature correction factors should be used to determine proper tensioning length	Based on Iowa DOT requirements.
Collect Strand Sample	1 seven ft. sample per size per source per year for tension test.	
Collect Rebar Sample	2 seven ft. samples per size per source per year for bending and tension test. Same samples to be used also for testing conformity of epoxy coating	
Form		
Length	Confirm Length	
Width	Confirm Width	
Height	Confirm Height	
Shearkey Dimensions	Inspect with QC Tech and document	
Chamfers	Inspect with QC Tech and document	
Dowel Pin Tube Locations	Inspect with QC Tech and document	
Post Tensioning Duct Size/Locations	Inspect with QC Tech and document	
Post Tensioning Duct Blockout Size (Fascia Beams)	Inspect with QC Tech and document	
Excess Form Oil to be Dry Mopped	Yes or No	
Form Ties and Inserts Recessed	Minimum of 1 inch	
Void Dimensions	Dimensions (inches)	
Void Location - Lateral, Vertical, and End	Location of voids	

During Pour

Note: Agency sampling and testing is performed on a random basis. Use random number sheet for sampling. The following frequencies are the mimimum recommendations.

Inspection Criteria	Recommendations	Remarks
Air Content	Frequency: At least once per element and every 100 CY	
Slump (Spread)	Frequency: At least once per element and every 100 CY	
J-ring (ASTM C1621)	For SCC Only. Frequency: At least once per element and every 100 CY	
Temperature	Frequency: At least once per element and every 100 CY	
Water/Cement	Frequency: At least once per element and every 100 CY	
Compression Cylinder Fabrication	Frequency: Once per element or every 100 CY; Number: Total 6 cylinders for permeability and strength testing; Curing: In the same conditions as the element itself (to be left with the element until destressing/form stripping). Consider using "IntelliCure" system.	
Void Location After Concrete Placement - Witness QC Checking Location after Hold Downs Removed	Inspect with QC Tech and document	
Lifting embedments/hooks	Placed at the proper location according to construction drawings	
Post-Pour		
Curing	Define the type of curing (water curing, chemical membrane curing, steam curing). The concrete in the form shall be maintained at a temperature of not less than 50˚F during the curing period (prior to stripping strength). Accelerated Curing – The controlling temperatures shall be those actually achieved within the concrete elements. Accelerated curing shall be started after the concrete has attained initial set. (ASTM C403, Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance). The concrete temperature may be increased during the preset period at a rate not to exceed 10˚F per hour. The total permissible temperature gain during the preset period shall not exceed 40˚F higher than the placement temperature or 104˚F, whichever is less. A heat gain not to exceed 36˚F per hour, measured in the concrete, is acceptable provided the concrete has attained initial set.	If accelerated heat(steam) curing is used, concrete should be maintained in warm and moist conditions while releasing the strands (IOWA DOT)
Detressing Strength Testing	Witness strength tests and document	
Destressing	Witness destressing of element	
Length	Length (feet)	
Width	Width (feet)	
Height	Height (feet)	
Sweep	Inspect with QC Tech and document	
Camber	Inspect with QC Tech and document	

Legend
Documentation / Should be in Inspection Report
Material Sampling and Testing at Plant
Material Testing in Lab on Samples cast at Plant

Surface Finish	Yes or No and type of finish	
Interior Beam Finish	Yes or No and type of finish	
Top Finish	Yes or No and type of finish	
Void Drains Opened	Yes or No	
Cold Joints/Laminations	Yes or No	
Cracks/Chips/Spalls	Yes or No and NCR if necessary	
Concrete Cleaned from Exposed Reinforcing	Yes or No	
Chamfer Smoothness/Uniformity	Inspect with QC Tech and document	
Post-Tensioning Duct Locations	Inspect with QC Tech and document	
Unit Identification	ID Number of element	
Permeability Testing	AASHTO T-358 “Surface Resistivity Indication of Concrete’s Ability to Resist Chloride Ion Penetration.”	Performed on compression cylinders
Compressive Strength Test	AASHTO T-22 "Compressive Strength of Cylindrical Concrete Specimens"	
Strand Tension Test		
Rebar Tension and Bending Test		

Structural Precast Elements

Inspection Criteria	Recommendations	Remarks
Pre-Pour		
Calibrations		
Cement Scales	Date of Last Calibration	
Aggregate Scales	Date of Last Calibration	
Water Meter	Date of Last Calibration	
Cylinder Compression Tester	Date of Last Calibration	
Producer's Air Meter	Date of Last Calibration. Ensure that calibration was done within last three months.	
Sequence of Concrete Placement	Once per each design/element type	
Reinforcing Steel		
Domestic Origin	Yes or No	
Confirm Manufacturer	Manufacturer Name	
Bar Size	Bar Size	
Bar Dimensions	Dimensions	
Bar Location in Form	Bar Locations	
Projection Above Form	Bar Projections	
Bar Quantities	Number of Bars	
Clearance	Clearance	
Dielectric Chairs (epoxy coated steel)	Yes or No	
Certificate of Conformance for Epoxy Coating	Provided by QC	
Splice Lap Lengths	Length of splice	
Coated Tie Wire (epoxy)	Yes or No	
Clean of Contaminants	Yes or No	
Collect Rebar Sample	2 seven ft. samples per size per source per year for bending and tension test. Same samples to be used also for testing conformity of epoxy coating	
Form		
Length	Confirm Length	
Width	Confirm Width	
Height	Confirm Height	
Shearkey Dimensions	Inspect with QC Tech and document	
Chamfers	Inspect with QC Tech and document	
Dowel Pin Tube Locations	Inspect with QC Tech and document	
Excess Form Oil to be Dry Mopped	Yes or No	
Form Ties and Inserts Recessed	Minimum of 1 inch	
Void Dimensions	Dimensions (inches)	
Void Location - Lateral, Vertical, and End	Location of voids	
During Pour		
Note: Agency sampling and testing is performed on a random basis. Use random number sheet for sampling. The following frequencies are the mimimum recommendations.		
Air Content	Frequency: At least once per element and every 100 CY	
Slump (Spread)	Frequency: At least once per element and every 100 CY	
J-ring (ASTM C1621)	For SCC Only. Frequency: At least once per element and every 100 CY	
Temperature	Frequency: At least once per element and every 100 CY	
Water/Cement	Frequency: At least once per element and every 100 CY	
Compression Cylinder Fabrication	Frequency: Once per element or every 100 CY; Number: Total 6 cylinders for permeability and strength testing; Curing: In the same conditions as the element itself (to be left with the element until destressing/form stripping). Consider using "IntelliCure" system.	
Void Location After Concrete Placement - Witness QC Checking Location after Hold Downs Removed	Inspect with QC Tech and document	
Post-Pour		
Stripping Strength Testing	Witness strength tests and document	
Length	Length (feet)	
Width	Width (feet)	
Height	Height (feet)	
Sweep	Inspect with QC Tech	
Camber	Inspect with QC Tech	
Surface Finish	Yes or No and type of finish	
Interior Beam Finish	Yes or No and type of finish	
Top Finish	Yes or No and type of finish	
Void Drains Opened	Yes or No	
Cold Joints/Laminations	Yes or No	
Cracks/Chips/Spalls	Yes or No and NCR if necessary	
Concrete Cleaned from Exposed Reinforcing	Yes or No	
Chamfer Smoothness/Uniformity	Inspect with QC Tech and document	
Unit Identification	ID Number of element	
Curing	Define the type of curing (water curing, chemical membrane curing, steam curing). The concrete in the form shall be maintained at a temperature of not less than 50˚F during the curing period (prior to stripping strength). Accelerated Curing – The controlling temperatures shall be those actually achieved within the concrete elements. Accelerated curing shall be started after the concrete has attained initial set. (ASTM C403, Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance). The concrete temperature may be increased during the preset period at a rate not to exceed 10˚F per hour. The total permissible temperature gain during the preset period shall not exceed 40˚F higher than the placement temperature or 104˚F, whichever is less. A heat gain not to exceed 36˚F per hour, measured in the concrete, is acceptable provided the concrete has attained initial set.	
Permeability Testing	AASHTO T-358 "Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration."	Performed on compression cylinders
Compressive Strength Test	AASHTO T-22 "Compressive Strength of Cylindrical Concrete Specimens"	
Rebar Tension and Bending Test		

Legend
Documentation / Should be in Inspection Report
Material Sampling and Testing at Plant
Material Testing in Lab on Samples cast at Plant

Non-Structural Precast Elements

Inspection Criteria	Recommendations	Remarks
Pre-Pour		
Calibrations		
Cement Scales	Date of Last Calibration	
Aggregate Scales	Date of Last Calibration	
Water Meter	Date of Last Calibration	
Stressing Jack	Date of Last Calibration	
Cylinder Compression Tester	Date of Last Calibration	
Producer's Air Meter	Date of Last Calibration. Ensure that calibration was done within last three months.	
Reinforcing Steel		
Domestic Origin	Yes or No	
Confirm Manufacturer	Manufacturer Name	
Bar Size	Bar Size	
Bar Dimensions	Dimensions	
Bar Location in Form	Bar Locations	
Projection Above Form	Bar Projections	
Bar Quantities	Number of Bars	
Clearance	Clearance	
Dielectric Chairs (epoxy coated steel)	Yes or No	
Certificate of Conformance for Epoxy Coating	Provided by QC	
Splice Lap Lengths	Length of splice	
Coated Tie Wire (epoxy)	Yes or No	
Clean of Contaminants	Yes or No	
Form		
Length	Confirm Length	
Width	Confirm Width	
Height	Confirm Height	
Shearkey Dimensions	Inspect with QC Tech and document	
Chamfers	Inspect with QC Tech and document	
Dowel Pin Tube Locations	Inspect with QC Tech and document	
Post Tensioning Duct Size/Locations	Inspect with QC Tech and document	
Post Tensioning Duct Blockout Size (Fascia Beams)	Inspect with QC Tech and document	
Excess Form Oil to be Dry Mopped	Yes or No	
Form Ties and Inserts Recessed	Minimum of 1 inch	
Void Dimensions	Dimensions (inches)	
Void Location - Lateral, Vertical, and End	Location of voids	
Void Location After Concrete Placement - Witness QC Checking Location after Hold Downs Removed	Inspect with QC Tech and document	
During Pour		

Note: Agency sampling and testing is performed on a random basis. Use random number sheet for sampling. The following frequencies are the mimimum recommendations.

Inspection Criteria	Recommendations	Remarks
Air Content	Frequency: Once per continuous pour	Continuous pour = Placement of same types of elements using same mix on a given day.
Slump (Spread)	Frequency: Once per continuous pour	
Temperature	Frequency: Once per continuous pour	
Water/Cement	Frequency: Once per continuous pour	
Compression Cylinder Fabrication	Frequency: Once per continuous pour; Number: Total 4 cylinders for strength testing; Curing: In the same conditions as the element itself (to be left with the element until form stripping).	
Post-Pour		
Stripping Strength Testing	Witness strength tests and document	
Length	Length (feet)	
Width	Width (feet)	
Height	Height (feet)	
Sweep	Inspect with QC Tech	
Camber	Inspect with QC Tech	
Surface Finish	Yes or No and type of finish	
Interior Beam Finish	Yes or No and type of finish	
Top Finish	Yes or No and type of finish	
Void Drains Opened	Yes or No	
Cold Joints/Laminations	Yes or No	
Cracks/Chips/Spalls	Yes or No and NCR if necessary	
Concrete Cleaned from Exposed Reinforcing	Yes or No	
Chamfer Smoothness/Uniformity	Inspect with QC Tech and document	
Post-Tensioning Duct Locations	Inspect with QC Tech and document	
Unit Identification	ID Number of element	
Curing		
Type of Curing	Specify the type of curing (wet/moist curing, chemical membrane curing, steam curing)	
Compressive Strength Test	AASHTO T-22 "Compressive Strength of Cylindrical Concrete Specimens"	

Legend

Legend
Documentation / Should be in Inspection Report
Material Sampling and Testing at Plant
Material Testing in Lab on Samples cast at Plant

Prestressed Elements

Plant Inspection	PCI Requirements	Modifications to PCI requirements / Explanations	Remarks
Plant Certifications and Qualifications			
Certification	PCI		
QC Qualification	PCI Level 2	A PCI level 1 with at least three years of experience under intermittent supervision of a level 2	Providing opportunities to level 1 technicians
PCI Groups	~~B1~~, B2, B3, B4, ~~C1~~, C2, C3, C4		B1&C1 are related to structural precast and should be omitted from here (PCI WEBSITE)
Safety measures	Not included	Use of steel screen/cage as a barrier, any other means to provide saftey	After the strands are tensioned there is a high possibility of strand breakage. (IOWA DOT)
QAI Office Requirements	Not included	RI DOT with office sharing. In additions to RI DOT requirement, internet connection to the computer for accessing agency specifications and a meeting table should be provided.	Not included in RI DOT spec
QSM	PCI MNL-116	Also need PCI MNL-137 for repair	Manual for evaluation and repair of precast, prestressed concrete bridge products
Plant Organization Chart	Not included	Should be provided by manufacturer and any changes in personnel should be informed ASAP	
Contractor Sampling and Testing Requirements			
Casting bed		Profile and Alignment of casting bed should be checked prior to concrete pour	
Plastic Concrete			
J-Ring test or L-box test (in case of SCC usage) (ASTM C1621)	Not included	For each mix design and at the start of each operation for each element	To measure the flowability of concrete if the concrete used for elements is SCC
Slump / Spread	At start of operations (first load), when making strength specimens, when the consistency of the concrete appears to vary (if consecutive tests are off by 0.5 inch, each load should be tested until consistant results are noticed), and at least once per every three air content tests		
Air	Minimum of one daily check per mix design or when making strength cylinders	and First load, min. once per element, if first load does not meet specification then each consecutive load until uniform results are observed.	
Unit Weight	At least once per week	and Each time the mixture design changes or its constituents change	
Temperature	When slump, air, or strength cylinders are made		
Cylinders			
Minimum Number to be cast	Four	and Additional four cylinders for destressing strength.	
Frequency of Casting	Daily for each indiviudal concrete mix, or for each 75 CY of a given mix design	and Min. once per element.	
Aggregates			
Coarse Fine	Every 1,000 tons Every 500 tons	and Once a week which comes first	Due to possibility of contaminations if the aggregate is stored for a long time
Cementitious Materials	If mill certificates are not provided, testing should be performed on each shipment		
Prestressing Strands	Testing is not required if mill reports are provided. If mill reports are not provided, it should be tested in accordance with ASTM A370	Even if the mill reports are provided one sample per heat number is required to be tested. (length of sample 2m)	ASTM A416, Grade 270: "standard specification for low-relaxation of seven strand prestressed concrete" is proper to test the strands (IOWA DOT,GEORGIA DOT, WS DOT and many other suppliers

Structural Precast Elements

Plant Inspection	NPCA or PCI Requirements		Additions to PCI or NPCA Requirements / Explanations	Remarks
	Certifications and Qualifications			
	Choose QSM Manual prior to Plant Inspection	Choose QSM Manual prior to Plant Inspection		
Certification	NPCA	PCI		
QC Qualification	ACI Level 2 or PCI Level 1 or future NETTCP PS Level 1	PCI Level 2	A PCI level 1 with at least three years of experience under intermittent supervision of a level 2	Providing opportunities to level 1 technicians
QSM Groups	-	B1, ~~B2, B3, B4~~, C1, ~~C2, C3, C4~~		only B1&C1 are related to structural precast and others should be omitted from here (PCI WEBSITE)
QAI Office Requirements	Not included	Not Included	RI DOT with office sharing. In additoions to RI DOT requirement, internet connection to the computer for accessing agency specifications and a meeting table should be provided.	
Plant Organization Chart			Should be provided by manufacturer and any changes in personnel should be informed ASAP	
QSM	NPCA	PCI MNL-116	Also need PCI MNL-137 for repair	Manual for evaluation and repair of precast, prestressed concrete bridge products
QSM Requirements				
Casting bed	Not included	Not Included	Profile and Alignment of casting bed should be checked prior to concrete pour	
Plastic Concrete				
J-Ring test or L-box test (in case of SCC usage) (ASTC C1621)	Not included	Not included	For each mix design and at the start of each operation for each element	To measure the flowability of concrete through reinforcing bars if the concrete used for elements is SCC
Slump	150 CY of concrete or once per day	At start of operations, when making strength specimens, when the consistency of the concrete appears to vary, and at least once per every three air content tests		
Air	150 CY of concrete or once per day	Minimum of one daily check per mix design or when making strength cylinders	and First load, min. once per element, if first load does not meet specification then each consecutive load until uniform results are observed.	
Unit Weight	150 CY of concrete or once per day	At least once per week	and each time the mixture design changes or its constituents change	
Temperature	When slump, air, or strength cylinders are made	When slump, air, or strength cylinders are made		
Cylinders				
Minimum Number to be cast	Four	Four		
Frequency of Casting	Every 150 CY of concrete for each mix or once per week, whichever comes first	Daily for each indiviudal concrete mix, or for each 75 CY of a given mix design	Min. once per each day's production or every 150 CY	
Aggregates				
Coarse	Every 2,000 tons	Every 1,000 tons	or minimum once a week whichever comes first	Due to possibility of contaminations if the aggregate is stored for a long time
Fine	Every 1,500 tons	Every 500 tons		
Cementitious Materials	Mill reports should be provided with each shipment	~~If mill certificates are not provided, testing should be performed on each shipment~~	Mill reports should be provided with each shipment	
Reinforcing Bars	Mill reports should be provided with each shipment	Testing is not required if mill reports are provided. If mill reports are not provided, it should be tested in accordance with ~~ASTM A370~~	If mill report not avialble, rebars from each shipment be tested as per corresponding specification (ASTM A706/A 706-M09 or ASTM A615/A615 M 09 depending on the type of rebar being used.)	

Non-Structural Precast

Plant Inspection	Requirements of NPCA	Modifications to NPCA Requirements / Explanations	Remarks
Certifications and Qualifications			
Certification	NPCA		
QC Qualification	ACI Level 2 or PCI Level 1 or future NETTCP PS Level 1		
NPCA Groups	-		
QAI Office Requirements	Not included	RI DOT with office sharing. In additoions to RI DOT requirement, internet connection to the computer for accessing agency specifications and a meeting table should be provided.	
QSM	NPCA		
QSM Requirements			
Plastic Concrete			
Slump	150 CY of concrete or once per day		
Air	150 CY of concrete or once per day		
Unit Weight	150 CY of concrete or once per day		
Temperature	When slump, air, or strength cylinders are made		
Cylinders			
Minimum Number to be cast	Four		
Frequency of Casting	Every 150 CY of concrete for each mix or ~~once per week~~, whichever comes first	Min. once per each day's production or every 150 CY	
Aggregates			
Coarse	Every 2,000 tons		
Fine	Every 1,500 tons		
Cementitious Materials	Mill reports should be provided with each shipment		
Reinforcing Steel	Mill reports should be provided with each shipment		