

INSPECTION TECHNICAL PROCEDURE

I-113

STRUCTURAL CONCRETE INSPECTION

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INSPECTION TECHNICAL PROCEDURE I-113, REV. 2

STRUCTURAL CONCRETE INSPECTION

1.0 PURPOSE

This inspection procedure provides guidance in assessing the Contractor's activities for the placement of structural concrete. This guidance is based on the requirements set forth in the Safety Requirements Document (SRD), the Integrated Safety Management Plan (ISMP), and the Quality Assurance Manual (QAM).

This procedure assesses the adequacy and effectiveness of the following:

- Construction implementing procedures
- Structural concrete construction activities
- Training and qualification of personnel
- System of records.

2.0 OBJECTIVES

This procedure provides guidance for the Office of Safety Regulation (OSR) to verify the Contractor has an effective program for the manufacture and placement of structural concrete in structures important-to-safety at the River Protection Project Waste Treatment Plant (RPP-WTP). This includes addressing programs for: (1) implementing commitments regarding structural concrete manufacture and placement; (2) managing and providing oversight to ensure that manufacture and placement of structural concrete and quality control (QC) have been adequately addressed by specifications, drawings, and procedures; and (3) managing and providing oversight to ensure the "as-constructed" condition of the structural concrete is in accordance with the design.

This procedure is a component of a complete construction inspection program. This and other inspection procedures will be used on an ongoing basis, as needed, to provide assurance that construction activities are being conducted as required by authorization basis commitments and Contractor procedures. Although it is expected during the construction phase a significant portion of this procedure will be accomplished at least once for each major Contractor/subcontractor involved with the activities addressed by this procedure, it is not expected that the entire procedure will be completed during any one inspection and/or every time the inspection procedure is used.

3.0 INSPECTION REQUIREMENTS

3.1 Assessing the Adequacy of the Contractor's Construction Implementing Procedures

- 3.1.1 The inspector should verify the Contractor/subcontractors with responsibilities in the important-to-safety structural concrete area have approved construction implementing procedures describing the administrative controls and work processes. (QAM, Policy Q-05, Sections 3.1.1 and 3.3; ISMP, Sections 1.3.9, 1.3.13, and 3.5, and Table 9-2; and SRD, Safety Criterion (SC) 4.1-2 and 7.3-5)
- 3.1.2 The inspector should verify procedures provide for inspections to ensure that important quality-related aspects of the concrete structural work are verified and documented. (QAM, Policy Q-05.1, Section 3.5.1; ISMP, Sections 1.3.9, 1.3.13, and 3.5, and Table 9-2; and SRD SC 4.1-2, and 7.3-7)
- 3.1.3 The inspector should verify the Contractor has established procedures for ensuring that craft and inspection personnel performing work on important-to-safety concrete structures are qualified to perform their assigned work. (QAM, Policy Q-02.2, Section 3.3.2; and ISMP, Sections 1.3.12, 3.5, 3.15 and 6.1.3, and Table 9-2)

3.2 Assessing the Implementation of the Contractor's Construction Activities

The inspector should verify the work is being accomplished under controlled conditions in accordance with the Contractor's approved procedures. (QAM, Policy Q-05.1, Section 3.1.1; SRD, SC 4.1-2 and 7.3-5 and ISMP, Sections 1.3.12, 3.5 and Table 9-2)

3.3 Assessing the Implementation of the Contractor's Personnel Training and Qualification Program

The inspector should verify the craft and QC personnel involved in the performance of important-to-safety structural concrete construction and inspection activities are qualified to perform their job functions. (QAM, Policy Q-02.2, Sections 3.3.1, 3.2.2, and 3.3.3; SRD, SC 7.2-2 and 7.3-3; and ISMP, Sections 1.3.12, 3.5, 3.15, and 6.1.3, and Table 9-2)

3.4 Assessing the Contractor's Implementation of the Records System

The inspector should verify those records demonstrating the achievement of required quality of the structural concrete installations are as specified by approved procedures, reviewed for accuracy and assurance that the recorded information meets project requirements, approved, and sufficiently stored and maintained to support technical requirements and contractual regulatory compliance. (QAM, Policy Q-17.1, Sections 3.1.2, 3.3.1 and 3.6.1; SRD, SC 4.0-3, 4.1-2, and 7.3-4; and ISMP, Section 8 and Table 8-1)

4.0 INSPECTION GUIDANCE

4.1 Assessing the Adequacy of the Contractor's Construction Implementing Procedures

- 4.1.1 The inspector should review the Contractor's procedures regarding the types of activities listed below for the manufacture and placement of structural concrete into structures important-to-safety and ensure that the requirements of the American Concrete Institute (ACI) Standards ACI 318-99 and ACI 318R-99 (applicable to structural), as well as the additional requirements of ACI 349-97 and ACI 349R-97 (applicable to nuclear important-to-safety concrete structures) are included in the procedures. (SRD SC 4.1-2, 4.1-3, and 4.1-4)

The inspector should review the Contractor's *Specification for Furnishing and Delivering Ready-Mix Concrete* (Document No. 24590-WTP-3PS-DB01-T0001) to obtain familiarity with the technical, inspection, testing, and quality requirements for structural concrete and ensure that the Contractor's procedures accomplish the specification requirements.

In particular, the inspector should review procedures for the following types of activities to ensure that they include the requirements of the ACI standards identified above and the specific elements as described below:

- Concrete mix design. Procedures should focus on the design of concrete mix with the compressive strength requirement specified by the applicable facility design documents and the supporting constituent material qualifications (i.e.: cement, flyash, sand, aggregate, water, admixtures)
- Batch-plant qualification and testing. Ensure the procedures accomplish batch plant qualification and testing as required by specification requirements
- Reinforcing steel installation. Ensure these procedures include provisions for the accomplishing and verifying minimum bend diameter; bar surface condition; bar placement and support, limits on spacing between bars and between the forms and the bars; splicing of bars using lap splices and mechanical/thermal sleeving processes; the splicing process and crews are qualified; the definition of each splice by materials used, location, crew, type of splice, and heat number (if applicable); sampling and testing performance frequency and acceptance criteria; and inspection performance during and after splicing
- Installation of concrete forms. Ensure the procedures include form installation in accordance with design drawings and requirements for prevention of mortar leakage, minimum reinforcing steel cover requirements (form to bar distance based upon concrete aggregate size), free of water or snow, and tying and bracing of forms to maintain the required shape and position
- Requirements for concrete joint preparation and cleanliness

- Batch-plant operation. Ensure procedures include the requirements of the American Society for Testing and Material (ASTM) Standard C 94, which is referenced in the above ACI standards, and ensure (1) the batch plant is producing concrete of the proper mix design, (2) scales and meters are calibrated, (3) equipment performs properly (rotation speed, timing, and blade wear are not excessive), (4) absence of contaminating material in the sand, aggregate or other concrete constituents, (5) batch plant records are generated, controlled, and indicate placement location, mix, volume, date, time, batch weight, constituent weights, and any special instructions, (6) water quality requirements are met, and (7) water quantity is adjusted to account for moisture content of aggregate and sand and are representative of actual stockpile conditions
- Embedded piping, structural steel items (sleeves, barrels, shear connectors, embedded plates, bolts, hangers). Piping or conduit embedments in or through concrete should be capped or plugged prior to concrete placement
- Equipment used to transport and place concrete (trucks, conveyors, pumps, and chutes) is in an acceptable condition and the time limit between mixing and delivery will not be exceeded
- Placement of concrete. Ensure that procedures include pre-placement planning and training completion, a pre-placement inspection has been completed, the placement has been cleaned and joint preparation requirements have been accomplished, a discussion on the use of trunks for vertical drops, limits on free-fall, and the criteria for operating pumps and conveyors, and the performance of inspections during placement
- Consolidating the concrete. Ensure that procedures address the attributes of vibration equipment and their operation, including vibrator size, frequency, testing, depth and spacing of insertion into the concrete, prohibitions against using consolidation equipment to drag concrete, liquefaction of the concrete surface, use of the proper number of vibrators, and special attention required for areas of high reinforcing steel or embedment steel congestion to preclude voids or honeycombing
- Curing concrete. Ensure that procedures include attributes of temperature control, surface preparation, and use and application of water/curing compounds and curing time
- Hot and cold weather concreting. Ensure that procedures ensure that concrete placed in cold weather must be kept above 40F and preferably in the range of 50 to 60F, the aggregate must not be frozen; and if concrete placed in hot weather results in a bulk temperature of concrete exceeding 80 or 90F, chilled water or flaked ice is used to provide cool concrete

4.1.2 The inspector should review the Contractor's construction implementing procedures to ensure that inspections and tests are provided to verify that the "as-built" condition of the

concrete structure conforms to drawing requirements and ensure that testing provisions conform to the requirements of Standards ACI 318-99, ACI 318R-99, ACI 349-97, and ACI 349R-97, as applicable.

In particular, the inspector should verify or examine the following attributes:

- The procedures or datasheets reference appropriate quantitative or qualitative acceptance criteria for determining that the prescribed activities have been accomplished satisfactorily
- The procedures require that the equipment used for process monitoring or data collection is calibrated and maintained
- Measures are provided to ensure aggregate and sand are stored, and so verified, in a manner to prevent deterioration or intrusion of foreign matter. This is to ensure contaminated material is not used for important-to-safety concrete. Aggregate testing (ASTM Standard C 33) should be performed for gradation and friable material content. In addition, sand and aggregate should be tested periodically for moisture content. The entrained moisture should be accounted for in the batch-plant water addition weights to ensure the water-to-cement ratio remains within mix design limits
- The procedures should provide for reinforcing steel verifications. This will ensure reinforcing steel is placed in accordance with design drawing requirements for quantity, location, and size, and include ACI Standard 318-99 requirements regarding spacing limits, surface conditions, bend diameters, supports, and splicing
- The procedures should provide measures to ensure ACI Standard 318-99 (Section 5.7) requirements for the preparation of concrete transportation equipment and the placement location are verified. This is usually accomplished by pre-placement inspection
- The procedures should provide measures to ensure ACI Standard 318-99 (Section 5.6) requirements regarding strength-test samples are met
- The procedures should provide measures to ensure the moisture contained in sand and aggregate is periodically measured and accounted for in the concrete batching process at the batch plant. In addition, ASTM Standard C 94 provides requirements for batch-plant operation and procedures should address those controls
- The procedures should provide measures to ensure ACI Standard 318-99 requirements for transporting concrete are met. The use of tempering water, drum revolution speed, drum condition, and the time between batching and delivery to the placement are particularly important

- The procedures should provide measures for the testing of concrete at the point of delivery to the placement. This will ensure the testing provisions of ACI Standard 318-99 are accomplished, as required, in accordance with the applicable ASTM standards. The testing program should provide for concrete sampling (ASTM Standard C 172), unit weight determination (ASTM Standard C 138), air content testing (ASTM Standard C 173), slump measurement (ASTM Standard C 143), concrete temperature measurement (ASTM Standard C 1064), concrete compressive test cylinder filling (ASTM Standard C 31), and capping (ASTM Standard C 617)
- The procedures should provide measures to ensure concrete curing activities are accomplished and verified as required by ACI Standard 318-99
- The procedures should provide measures to ensure concrete strength-test cylinders are cured, stored, and tested for compressive strength in accordance with ACI Standard 318-99 requirements.

4.1.3 No additional guidance is necessary.

4.2 Assessing the Implementation of the Contractor's Construction Activities

Before performing work observation inspections in the field, the inspector should review the Contractor's procedures for accomplishing concrete manufacture, placement, and testing activities; ACI Standards 318-99, 318R-99, 349-97, and 349R-97; and the ASTM standards, as specified in Section 4.1.2 above, applicable to the work to be observed. During the field observations, the inspector should carry a copy of the procedure(s) and the industry standard(s) pertinent to the planned observations and verify a broad selection of the attributes provided in Section 4.1, above.

During the field observations, the inspector should interview a sample of the craft and QC personnel performing the observed activities. The interviews should focus on determining whether job and procedure knowledge is satisfactory. The names and job functions of those interviewed should be obtained for later use in verifying proper implementation of personnel qualification requirements as specified in Sections 4.3 and 4.4, below.

After the Contractor has completed pre-placement inspections, the inspector should conduct an independent inspection of a sample of the preparatory work, using the Contractor's checklist, to assess the thoroughness of the Contractor's inspections. The inspector should focus on ensuring reinforcing steel installation and configuration conform to drawing and procedure requirements; concrete forms conform to drawing and procedure requirements; and placement conditions are clean and free of standing water.

In addition to the attributes selected for verification from Section 4.1, above, the inspector should inspect the following additional areas/activities during work observation activities:

- Sand and aggregate storage areas to ensure the material is not contaminated with foreign material
- Batch-plant operation and record generation to ensure compliance with ASTM Standard C 94
- Cleanliness and condition of the truck drums to ensure the drum internals are in good condition and free of excessive wear and contaminants
- Testing activities at the point of placement, including compressive strength-test cylinder sampling, filling, and capping (see Section 4.1.2 for specific standards)
- Concrete curing activities (see ACI Standard 318-99).

In addition, the inspector should thoroughly inspect, at least once, the storage and curing facility for the concrete compressive strength-test cylinders to ensure conformance to ACI and ASTM standard requirements. Partial inspections of the facility, as deemed necessary, are sufficient after the thorough inspection.

The inspector should examine the activities to determine the compressive strength of concrete cylinders to verify conformance with ASTM standard requirements. This examination should be performed in a thorough manner at least once; partial inspections, as deemed necessary, may be performed thereafter.

4.3 Assessing the Implementation of the Contractor's Personnel Training and Qualification Program

The inspector should review the Contractor's procedures that specify the requirements for education, experience, training, and certification of craft and QC personnel whose work responsibilities are associated with structural concrete. If not accomplished during performance of activities in Section 4.2, the inspector should interview and collect the names of at least the following personnel:

- One batch plant operator
- One craftsperson performing concrete testing activities at the placement location
- One operator of consolidation/vibration equipment
- Two QC personnel involved in concrete placement inspection activities
- One operator of the concrete compressive test cylinder curing facility
- One craftsperson operating the concrete compressive strength-test cylinder testing facility.

During the interviews, the inspector should verify the respective personnel are sufficiently knowledgeable of applicable procedural requirements.

The inspector also should examine the training and qualification records of the craft and QC personnel interviewed. The inspector should determine whether the records demonstrate conformance to the Contractor's requirements for personnel training, qualification, and certification.

4.4 Assessing the Contractor's Implementations of the Records System

The inspector should sample and examine the completed records that were generated during the concrete placement activities observed in Section 4.2. This inspection should focus on verifying the records conform to applicable procedures and to applicable ACI and ASTM standard requirements.

The records for concrete placement and for the training and qualification of personnel should be examined to verify approval by proper authority; storage and maintenance in accordance with procedural requirements; and the acceptable performance of the documented activity.

5.0 REFERENCES

ACI Standard 318-99, *Building Code Requirements for Structural Concrete*, American Concrete Institute, 1999.

ACI Standard 318R-99, *Commentary on Building Code Requirements for Structural Concrete*, American Concrete Institute, 1999.

ACI Standard 349-97, *Code Requirements for Nuclear Safety Related Concrete Structures*, American Concrete Institute, 1997.

ACI Standard 349R-97, *Commentary on Code Requirements for Nuclear Safety Related Concrete Structures*, American Concrete Institute, 1997.

ASTM Standard C 31, *Practice for Making and Curing Concrete Test Specimens in the Field*, American Society for Testing and Materials, 1996.

ASTM Standard C 33, *Specification for Concrete Aggregates*, American Society for Testing and Materials, 1993.

ASTM Standard C 94, *Specification for Ready Mixed Concrete*, American Society for Testing and Materials, 1996.

ASTM Standard C 138, *Test Method for Unit Weight, Yield, and Air Content of Concrete*, American Society for Testing and Materials, 1992.

ASTM Standard C 143, *Test Method for Slump of Hydraulic Cement Concrete*, American Society for Testing and Materials, 1990.

ASTM Standard C 172, *Practice for Sampling Freshly Mixed Concrete*, American Society for Testing and Materials, 1990.

ASTM Standard C 173, *Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method*, American Society for Testing and Materials, 1994.

ASTM Standard C 617, *Practice for Capping Cylindrical Concrete Specimens*, American Society for Testing and Materials, 1994.

ASTM Standard C 1064, *Test Method for Temperature of Freshly Mixed Portland-Cement Concrete*, American Society for Testing and Materials, 1986.

Integrated Safety Management Plan, BNFL-5193-ISP-01, Rev. 5, Bechtel National, Inc., Richland, Washington, 2001.

Quality Assurance Manual, 24590-WTP-QAM-QA-01-001, Revision 0, Bechtel National, Inc., Richland, Washington, 2001.

Safety Requirements Document, BNFL-5193-SRD-01-02, Rev. 4, Bechtel National, Inc., Richland, Washington, 2001.

6.0 LIST OF TERMS

ACI	American Concrete Institute
ASTM	American Society for Testing and Materials
ISMP	Integrated Safety Management Plan
QAM	Quality Assurance Manual
QC	quality control
RPP-WTP	River Protection Project Waste Treatment Plant
SC	Safety Criteria
SRD	Safety Requirements Document

Attachments: None

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