

# NRC INSPECTION MANUAL

DQASIP

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## INSPECTION PROCEDURE 46051

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### STRUCTURAL CONCRETE PROCEDURE REVIEW

PROGRAM APPLICABILITY: 2512

#### 46051-01 INSPECTION OBJECTIVES

01.01 To determine whether the technical requirements detailed or referenced in Chapter 3 of the SAR associated with structural concrete have been adequately addressed in the construction specifications, drawings, and work procedures, and whether the established system of management controls is adequate.

01.02 To determine whether quality assurance plans, instructions and procedures for structural concrete have been established in the facility QA manual, and whether these documents conform to the QA program as described in Chapter 17 of the SAR.

01.03 To determine whether specification or procedural inadequacies associated with structural concrete indicate any potentially generic problems or other weaknesses within the preparing technical organization.

#### Inspection Schedule

##### May Be Started

Three months before  
issuance of CP (or LWA)

##### Must Be Started

Before safety-related concrete  
placement  
is started

##### Must Be Completed

Before any containment  
exterior walls are placed

#### 46051-02 INSPECTION REQUIREMENTS

02.01 For each onsite organization with QA/QC responsibilities relative to structural concrete complete the inspection requirements of Inspection Procedure (IP) 35100 relative to this area. Usually IP 35100 will be completed prior to conducting the inspection requirements of this section. If there are multiple contractors with QA/QC responsibilities in this area the region may inspect a sample, using engineering judgment concerning the safety significance and complexity of the work activity.

02.02 Determine whether the licensee has an established audit program (including plans, procedures, and schedule) covering the safety-related work and control functions in the area of structural concrete.

02.03 Determine whether the licensee has an established audit program for ensuring that all examination and inspection personnel associated with structural concrete are qualified to perform their assigned work. Determine whether a program has been established to train craft personnel in their assigned tasks.

02.04 Review the concrete mix designs, supporting material qualifications, and testing to be used in Category I structures. If more than three Category I concrete mix designs are used, the region may review a sample of the highest strength or most used mixes and the associated material qualifications. Rereview may be necessary if significant mix changes are made.

02.05 Review all construction specifications related to concrete activities and ascertain whether the specified technical requirements conform to the commitments contained in Chapter 3 of the SAR.

02.06 Review the construction and QC procedures generated from the specifications and determine their adequacy with respect to prescribing adequate methods for achieving the construction specification requirements.

02.07 Additional inspections, as determined by Regional management, may be conducted in the inspection areas covered above when licensee performance is classified as Category 3 by the SALP program, or if Regional management concludes that recent findings will likely result in a SALP Category 3 rating. In these cases, particular consideration should be given to an expanded sample of items to be inspected under Section 02.02, 02.06 above.

#### 46051-03 INSPECTION GUIDANCE

General Guidance. Applicable portions of the SAR (3.1, 3.2, 3.8 and 17.1), the SER, and NRR/licensee questions and answers should be reviewed to determine licensee commitments relative to construction and inspection requirements prior to performing this inspection. The inspector should then utilize these documents during the review of the construction specifications. The implementing QA/QC and construction procedures should subsequently be reviewed with the applicable specification and QA Manual in mind. Most of this review can be completed during inspection preparation after these procedures have been obtained from the site.

Findings from this inspection activity should address each item in 02, above, as being satisfactory, being unresolved and requiring resolution, or being in violation and requiring correction. When significant inadequacies are identified in specifications or procedures indicating weakness within the preparing technical organization, the inspector should inform cognizant regional supervision. The issue should be addressed at the appropriate level of licensee management.

Specific information concerning the licensee's plans and schedules for performing comprehensive audits and on-going surveillances of concreting activities should be defined as a result of this inspection. Information should be obtained about audit procedures, schedules, scope and auditor qualifications. Licensee onsite QA staffing and surveillance plans should ensure that contractor QC activities are sufficiently monitored and evaluated. QA/QC inspection and construction procedures should be reviewed and compared with the requirements of the applicable codes and construction specifications. Evaluation should result in a sound indication that all quality-related construction and inspections will be adequately performed by qualified personnel and will be based on appropriate criteria and further, that the results of inspections will be transmitted to responsible quality assurance and management personnel. Refer to IP 35100 for additional guidance.

This inspection procedure requires a specific technical review of concrete mix designs and supporting material qualifications. In addition, the technical adequacy of implementing

construction and QC procedures must be determined. For these reasons, this inspection procedure should be performed by an inspector who is able to evaluate civil engineering activities.

### 03.01 Specific Guidance

Note: The numbering of the guidance below refers to specific subsections of 02, above.

02.01 The inspector should also review the appropriate version of ANSI N45.2.5 "Supplementary Quality Assurance Requirements for Installation, Inspection, and Testing of Structural Concrete, Structural Steel, Soils, and Foundations During the Construction Phase of Nuclear Power Plants," if cited by the licensee. Specific attention should also be given to the quality assurance program needs that may result from the distribution of contractual responsibilities. Examples of these needs may be: provisions for adequate on-site engineering direction, appropriate and adequate procedures related to procurement and use of materials, adequate control of hold points, and formalization of design changes for incorporation into as-built drawings.

02.05 The construction specification must translate the design requirements into details sufficient to define the acceptance testing requirements and it should specify the personnel and interface responsibilities required to define, control, and resolve field problems or design problems that are evidenced during construction.

02.06 QA/QC procedures must provide for effective inspections which will assure that work is performed in accordance with specification requirements. Inspections should require verification of specified controls and should not be accomplished merely by surveillance. Laboratory and field testing procedures must provide for verification of correct material usage, correct selection of reference standards, and should prohibit discretionary selection of inspection and testing parameters on the part of inspectors. Construction procedures must reference the required inspection hold points and must also address the quality assurance department authority to stop work.

The items selected for review during this inspection should include the following items as appropriate for the specific site design. The review of procedures, specifications, and drawings should ensure that the following activities are controlled and performed in accordance with applicable requirements. (\*denotes the more safety significant activities.)

#### a. Control of Specific Materials

- \*1. Reinforcing steel
- \*2. Reinforcing splicing (mechanical and welded) material
- \*3. Concrete mix materials (cement, fly ash, sand, aggregate, water, admixtures, etc.) and all constituents used in other cement-like materials such as gunite, grout, dry pack or manufactured materials such as epoxy.
4. Waterproof membrane and water stops
5. Grounding and cathodic protection
6. Sumps, drains, and grating material
- \*7. Embedded piping
- \*8. Liner plate and anchorage system

- \*9. Mechanical and electrical penetrations (sleeves/barrels - not penetration assemblies)
- \*10. Off-the-shelf anchorage components and embedments (bolts, hangers, inserts, etc.)
- \*11. Embedded structural steel items (shear connectors, embedded plates, etc.)
- 12. Joint materials and sealants, including materials used for separation between adjacent structures
- 13. Materials used during construction such as for construction joint preparation, form release agents, and curing
- \*14. Post-tensioning system embeds such as bearing plates, trumpets and sheathing
- 15. Embedded structural instrumentation
- 16. Other structural concrete materials that may be used

b. Control of Specific Processes or Activities

- 1. Installation and testing of waterproof membrane
- \*2. Reinforcing steel fabrication, placement, splicing and testing
- \*3. Qualification of concrete production facility
- \*4. Installation of embedded items
- \*5. Installation of liner plate
- \*6. Installation of formwork
- 7. Surveying activities subject to QA program (unless the surveying organization was reviewed under IP 45051)
- \*8. Preparation for concrete placement and preplacement inspections
- \*9. Production of concrete
- \*10. Transportation and in process testing of concrete
- \*11. Concrete placement and fixity of embedded items and formwork
- \*12. Concrete curing
- \*13. Postplacement inspection
- \*14. Material and concrete production testing, analysis and evaluation of results
- 15. Other structural concrete activities - as applicable
- \*16. Documentation of inspection and testing results

\*17. Final inspection

46051-04 REFERENCES

The following are some codes and other references that may apply: (The applicable edition or revision of codes and standards should be stated in the SAR.)

American Concrete Institute

- ACI 359 Code for Concrete Reactor Vessels and Containments (also known as ASME, B&PV Code, Section III, Division 2)
- ACI 349 Code Requirements for Nuclear Safety-Related Concrete Structures
- ACI 318 Building Code Requirements for Reinforced Concrete
- ACI 301 Specifications for Structural Concrete for Buildings
- ACI 531 Building Code Requirements for Concrete Masonry Structures
- ACI 211.1 Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete
- ACI 212.1 Admixtures for Concrete
- ACI 212.2 Guide for Use of Admixtures in Concrete
- ACI 214 Recommended Practice for Evaluation of Compression Test Results of Field Concrete
- ACI 221 Selection and Use of Aggregates for Concrete
- ACI 304 Recommended Practice for Measuring, Mixing, and Placing Concrete
- ACI 304.2 Placing Concrete by Pumping Methods
- ACI 305 Recommended Practice for Hot Weather Concreting
- ACI 306 Recommended Practice for Cold Weather Concreting
- ACI 308 Recommended Practice for Curing Concrete
- ACI 309 Recommended Practice for Consolidation of Concrete
- ACI 311 Recommended Practice for Concrete Inspection
- ACI 311.1 ACI Manual of Concrete Inspection
- ACI 311.2 Training Courses for Concrete Inspectors
- ACI 311.3 Guide for Certification of Nuclear Concrete Inspection and Testing Personnel
- ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
- ACI 347 Recommended Practice for Concrete Formwork

- ACI 503 Use of Epoxy Compounds With Concrete
- ACI 503.4 Standard Specification for Repairing Concrete With Epoxy Mortar
- ACI 504 Guide to Joint Sealants for Concrete Structures
- ACI 506 Recommended Practice for Shotcreting
- ACI 506.2 Specification for Materials, Proportioning and Application of Shotcrete

American Welding Society

- AWS D1.1 Structural Welding Code
- AWS D1.4 Structural Welding Code - Reinforcing Steel
- AWS D12.1 Reinforcing Steel - Welding Code

American Association of State Highway Officials

T-26 Method of Test for Quality of Water to Be Used in Concrete

National Ready Mixed Concrete Association

Concrete Plant Standards of the Concrete Plant Manufacturers Bureau

Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau

American Society for Testing and Materials

- ASTM A-615 Deformed Billet-Steel Bars for Concrete Reinforcement
- ASTM A-706 Standard Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement
- ASTM C-29 Test for Unit Weight of Aggregate
- ASTM C-31 Making and Curing Concrete Compressive and Flexural Strength Test Specimens in the Field
- ASTM C-33 Standard Specification for Concrete Aggregates
- ASTM C-39 Test for Compressive Strength of Molded Concrete Cylinders
- ASTM C-40 Test for Organic Impurities in Sands for Concrete
- ASTM C-78 Test for Flexural Strength of Concrete
- ASTM C-88 Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C-94 Standard Specification for Ready Mixed Concrete
- ASTM C-109 Standard Method of Test for Compressive Strength of Hydraulic Cement Mortar (Using 2-in. Cube Specimen)
- ASTM C-114 Chemical Analysis of Hydraulic Cement

ASTM C-115 Test for Fineness of Portland Cement by the Turbidimeter

ASTM C-117 Test for Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing

ASTM C-123 Test for Lightweight Pieces in Aggregate

ASTM C-127 Test for Specific Gravity and Absorption of Coarse Aggregate

ASTM C-128 Test for Specific Gravity and Absorption of Fine Aggregate

ASTM C-131 Test for Resistance to Abrasion of Small Coarse Aggregate by Use of the Los Angeles Machine

ASTM C-136 Test for Sieve or Screen Analysis of Fine and Coarse Aggregates

ASTM C-138 Tentative Method of Test for Unit Weight, Yield and Air Content (Gravimetric) of Concrete

ASTM C-142 Test for Friable Particles in Aggregates

ASTM C-143 Test for Slump of Portland Cement Concrete

ASTM C-144 Standard Specification for Aggregate for Masonry Mortar

ASTM C-150 Specification for Portland Cement

ASTM C-151 Autoclave Expansion of Portland Cement

ASTM C-157 Test for Length Change of Hardened Cement Mortar and Concrete

ASTM C-171 Specification for Sheet Materials for Curing Concrete

ASTM C-172 Sampling Fresh Concrete

ASTM C-173 Test for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C-191 Time of Setting of Hydraulic Cement by Vicat Needle

ASTM C-192 Making and Curing Concrete Test Specimens in the Laboratory

ASTM C-204 Test for Fineness of Portland Cement by Air Permeability Apparatus

ASTM C-231 Test for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C-235 Standard Method of Test for Scratch Hardness of Coarse Aggregate Particles

ASTM C-260 Standard Specifications for Air Entraining Admixtures for Concrete

ASTM C-266 Test for Time of Setting of Hydraulic Cement by Gilmore Needles

ASTM C-289 Standard Method of Test for Potential Reactivity of Aggregates (Chemical Method)

ASTM C-309 Specification for Liquid Membrane - Forming Compounds for Curing Concrete

ASTM C-311 Sampling and Testing Fly Ash for Use As an Admixture in Portland Cement Concrete

ASTM C-430 Test for Fineness of Hydraulic Cement by No. 325 Sieve

ASTM C-441 Standard Method of Test for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction

ASTM C-469 Test for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

ASTM C-494 Standard Specification for Chemical Admixture for Concrete

ASTM C-496 Testing for Splitting Tensile Strength of Cylindrical Concrete Specimens

ASTM C-512 Test for Creep of Concrete in Compression

ASTM C-535 Test for Resistance to Abrasion of Large Size Coarse Aggregate by Use of the Los Angeles Machine

ASTM C-566 Standard Method of Test for Total Moisture Content of Aggregate by Drying

ASTM C-618 Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete

ASTM C-637 Standard Specification for Aggregates for Radiation Shielding Concrete

ASTM C-642 Test for Specific Gravity, Absorption, and Voids in Hardened Concrete

ASTM D-512 Test for Chloride Ion in Industrial Water and Industrial Waste Water

ASTM D-1411 Tests for Water Soluble Chlorides Present as Admixes in Graded Aggregate Road Mixes

ASTM D-1888 Tests for Particulate and Dissolved Matter in Water

ASTM E-329 Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials As Used in Construction

#### Corps of Engineers - U. S. Army

CRD C-36 Method of Test for Thermal Diffusivity of Concrete

CFD C-39 Method of Test for Linear Thermal Expansion of Concrete

CRD C-44 Method for Calculation of Thermal Conductivity of Concrete

CRD C-119 Method of Test for Flat and Elongated Particles in Coarse Aggregate

#### Others

SAR, Chapters 1, 3 and 17, including pertinent codes and standards referenced in these chapters.

Regulatory Guide 1.10, Mechanical (Cadweld) Splices in Reinforcing Bars of Category I Concrete Structures.<sup>1</sup>

Regulatory Guide 1.15, Testing of Reinforcing Bars for Category I Concrete Structures.<sup>1</sup>

Regulatory Guide 1.18, Structural Acceptance Test for Concrete Primary Reactor Containments.<sup>1</sup>

Regulatory Guide 1.19, Nondestructive Examination of Primary Containment Liner Welds.<sup>1</sup>

Regulatory Guide 1.28, Quality Assurance Program Requirements (Design and Construction).

Regulatory Guide 1.29, Seismic Design Classification.

Regulatory Guide 1.38, Quality Assurance Requirements for Packing, Shipping, Receiving, Storage, and Handling of Items for Water-Cooled Nuclear Power Plants.

Regulatory Guide 1.55, Concrete Placement in Category I Structures.<sup>1</sup>

Regulatory Guide 1.58, Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel.

Regulatory Guide 1.88, Collection, Storage, and Maintenance of Nuclear Power Plant Quality Assurance Records.

Regulatory Guide 1.94, Quality Assurance Requirements for Installation, Inspection, and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants.

Regulatory Guide 1.103, Post-Tensioned Prestressing Systems for Concrete Reactor Vessels and Containments.<sup>1</sup>

Regulatory Guide 1.107, Qualifications for Cement Grouting for Prestressing Tendons in Containment Structures.

Regulatory Guide 1.123, Quality Assurance Requirements for Control of Procurement of Items and Services for Nuclear Power Plants.

Regulatory Guide 1.136, Materials, Construction, and Testing of Concrete Containments.

Regulatory Guide 1.142, Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments).

Regulatory Guide 1.146, Qualification of Quality Assurance Program Audit Personnel for Nuclear Power Plants.

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<sup>1</sup> This Regulatory Guide was withdrawn by Regulatory Guide 1.136, Revision 2, June 1981. Implementation of Regulatory Guide 1.136, Revision 2 is for applications docketed after May 1981.