ACI 301 - Specifications for Structural Concrete

Subcommittee A --- General Requirements, Definitions, Tolerances

Kansas City

Sunday November 6, 2005
1:00 PM – 5:00 PM Room C 2214

Agenda

1. Call to Order
2. Introduction of Members (Exhibit 2)
3. Review of Subcommittee Scope
4. Review of Section 1 ACI 301-05 (Exhibit 4)
5. Review of Lobo comments (Exhibit 5)
6. Action Items
7. Adjourn

Kansas City Exhibit 2

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ACI 301-05

Specifications for Structural Concrete

An ACI Standard

Reported by ACI Committee 301

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This specification is a Reference Specification that the Engineer or Architect can make applicable to any construction project by citing it in the Project Specifications. The Architect/Engineer supplements the provisions of this Reference Specification as needed by designating or specifying individual project requirements.

The document covers materials and proportioning of concrete; reinforcing and prestressing steels; production, placing, finishing, and curing of concrete; and formwork design and construction. Methods of treatment of joints and embedded items, repair of surface defects, and finishing of formed and unformed surfaces are specified. Separate sections are devoted to architectural concrete, lightweight concrete, mass concrete, prestressed concrete, and shrinkage-compensating concrete. Provisions governing testing, evaluation, and acceptance of concrete as well as acceptance of the structures are included.

Keywords: admixture; aggregate; air entrainment; architectural concrete; cement; cementitious materials; cold weather; compressive strength; concrete; concrete construction; concrete durability; concrete slab; consolidation; conveyor; curing; density; exposed-aggregate finish; finish; floors; formwork; grout; grouting; hot-weather; inspection; joint (construction, contraction, and isolation); lightweight concrete; mix; mixture proportion; placing; prestressed concrete; prestressing steel; reinforced concrete; reinforcement; repair; reshoring; shoring; shrinkage-compensating concrete; specification; subgrade; temperature; test; tolerance; water-cementitious material ratio; welded wire reinforcement.

NOTES TO SPECIFIER

This specification is incorporated by reference in the project specifications using the wording in P3 of the preface and including the information from the mandatory, optional, and submittal checklists following the specification.

PREFACE

P1. ACI Specification 301 is intended to be used by reference or incorporation in its entirety in the Project Specification. Do not copy individual Parts, Sections, Articles, or Paragraphs into the Project Specification, because taking them out of context may change their meaning.

P2. If Sections or Parts of ACI Specification 301 are copied into the Project Specification or any other document,

ACI 301-05 supersedes ACI 301-99 and became effective April 20, 2005.

do not refer to them as an ACI Specification, because the specification has been altered.

P3. A statement such as the following will serve to make ACI Specification 301 a part of the Project Specification:

"Work on (Project Title) shall conform to all requirements of ACI 301-05 published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by these Contract Documents."

P4. Each technical Section of ACI Specification 301 is written in the three-part Section format of the Construction Specifications Institute, as adapted for ACI requirements. The language is imperative and terse.

P5. The Specification is written to the Contractor. When a provision of this specification requires action on the Contractor's part, the verb "shall" is used. If the Contractor is allowed to exercise an option, the verb "may" or, when limited alternatives are available, the conjunctive phrase "shall either... or..." is used. Statements provided in the specification as information to the contractor use the verbs "may" or "will." Informational statements typically identify activities or options that "will" be taken or "may" be taken by the Owner or the Architect/Engineer.

CONTENTS

SECTION 1—GENERAL REQUIREMENTS

1.1—Scope

1.1.1 *Work specified*—This Specification covers cast-in-place structural concrete.

Provisions of this Specification shall govern except where other provisions are specified in the Contract Documents.

1.1.2 *Work not specified*—The following subjects are not in the scope of this specification:

- Precast concrete products;
- Heavyweight shielding concrete;
- Slipformed paving concrete;
- Terrazzo;
- Insulating concrete;
- Refractory concrete;
- Shotcrete;
- Slipformed concrete walls; and
- Tilt-up concrete construction.

1.2—Definitions

acceptable or **accepted**—acceptable to or accepted by the Architect/Engineer.

ACI Concrete Field Testing Technician Grade 1—a person who has demonstrated knowledge and ability to perform and record the results of ASTM standard tests on freshly mixed concrete and to make and cure test specimens. Such knowledge and ability shall be demonstrated by passing prescribed written and performance examinations and having credentials that are current with the American Concrete Institute.

Architect/Engineer or **Engineer/Architect**—the Architect, Engineer, architectural firm, engineering firm, or architectural and engineering firm issuing project drawings and

specifications or administering work under the Contract Documents.

architectural concrete—concrete that is exposed as an interior or exterior surface in the completed structure and is designated as architectural concrete in the Contract Documents; contributes to visual character of the completed structure and therefore requires special care in the selection of the concrete materials, forming, placing, and finishing to obtain the desired architectural appearance.

backshores—shores placed snugly under a concrete slab or structural member after the original formwork and shores have been removed from a small area at a time, without allowing the slab or member to deflect, or support its own weight or existing construction loads from above.

cement, expansive—a cement that, when mixed with water, produces a paste that, after setting, tends to increase in volume to a significantly greater degree than does portland cement paste; used to compensate for volume decrease due to shrinkage or to induce tensile stress in reinforcement.

cement, expansive Type K—a mixture of portland cement, anhydrous tetracalcium trialuminate sulfate ($C_4A_3S\bullet$), calcium sulfate ($CaSO_4$), and lime (CaO); the $C_4A_3\overline{S}$ is a constituent of a separately burned clinker that is interground with portland cement, or alternatively, is formed simultaneously with the portland-cement clinker compounds during the burning process.

Contract Documents—a set of documents supplied by Owner to Contractor as the basis for construction; these documents contain contract forms, contract conditions, specifications, drawings, addenda, and contract changes.

Contractor—the person, firm, or entity under contract for construction of the Work.

duct—a conduit (plain or corrugated) to accommodate prestressing steel for post-tensioned concrete.

exposed to public view—situated so that it can be seen from a public location after completion of the building.

high-early-strength concrete—concrete that is capable of attaining specified strength at an earlier age than 28 days through the use of high-early-strength cement or admixtures.

lightweight concrete—concrete of substantially lower density than normalweight concrete.

mass concrete—any volume of concrete with dimensions large enough to require that measures be taken to cope with generation of heat from hydration of the cement and attendant volume change to minimize cracking.

mass concrete, plain—Mass concrete containing no reinforcement or less reinforcement than necessary to be considered reinforced mass concrete.

mass concrete, reinforced—mass concrete containing adequate prestressed or nonprestressed reinforcement to act together with the concrete in resisting forces including those induced by temperature and shrinkage.

normalweight concrete—concrete having a density of approximately 150 lb/ft^3 made with gravel or crushed stone aggregates.

Owner—the corporation, association, partnership, individual, public body, or authority for whom the Work is constructed.

permitted—accepted or acceptable to the Architect/Engineer; usually pertains to a request by the Contractor, or to an item specified in the Contract Documents.

post-tensioning—a method of prestressing reinforced concrete in which tendons are tensioned after the concrete has hardened.

prestressed concrete—concrete in which internal stresses of sufficient magnitude and distribution are introduced to counteract to a desired degree the tensile stresses resulting from the service loads; in reinforced concrete, the prestress is commonly introduced by tensioning the tendons.

project drawings—graphic presentation of project requirements.

project specifications—the written document that details requirements for the Work in accordance with service parameters and other specific criteria.

reference specification—a standardized mandatory-language document prescribing materials, dimensions, and workmanship, incorporated by reference in Contract Documents, with information in the Mandatory Requirements Checklist required to be provided in the Project Specification.

reference standards—standardized mandatory-language documents of a technical society, organization, or association, including codes of local or federal authorities, which are incorporated by reference in Contract Documents.

required—required in this Specification or the Contract Documents.

reshores—shores placed snugly under a stripped concrete slab or other structural member after the original forms and shores have been removed from a large area, thus requiring the new slab or structural member to deflect and support its own weight and existing construction loads applied before the installation of the reshores.

sheathing, prestressing—a material encasing prestressing steel to prevent bonding of the prestressing steel with the surrounding concrete, to provide corrosion protection, and to contain the corrosion-inhibiting coating.

sheathing, wood formwork—the materials forming the contact face of forms; also called lagging or sheeting.

shop drawing—a drawing that provides details for a particular task that is developed by the Contractor and reviewed by the Engineer. The shop drawing is prepared to the requirements of the project drawings and project specifications.

shore—a temporary support designed to support formwork, fresh concrete, and construction loads from above for recently built structures that have not developed full design strength.

shrinkage-compensating concrete—a concrete made using an expansive cement that increases in volume after setting, designed to induce compressive stresses in elastically restrained concrete to approximately offset the tensile stresses resulting from drying shrinkage.

strength test—the average of the compressive strengths of two or more cylinders made from the same sample of concrete and tested at 28 days or at the specified test age.

structural lightweight concrete—Structural concrete made with lightweight aggregate; the equilibrium density, as

calculated by ASTM C 567, usually is in the range of 90 to 115 lb/ft^3 with a minimum compressive strength of 2500 psi.

submitted—documents or materials provided to Architect/Engineer for review or acceptance.

Work—the entire construction or separately identifiable parts thereof required to be furnished under Contract Documents.

1.3—Reference standards and cited publications

1.3.1 *Reference standards*—Standards of ACI, ASTM, CRD, and AWS referred to in this Specification are listed with serial designation including year of adoption or revision and are part of this Specification.

1.3.1.1 *ACI standards*

ACI 117-90	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 423.6-01	Specification for Unbonded Single-Strand Tendons

1.3.1.2 *ASTM standards*

A 82-02	Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
A 184/ A 184M-01	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
A 185-02	Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
A 416/A 416M-02	Standard Specification for Steel Strand, Uncoated Seven-Wire, for Prestressed Concrete
A 421/A 421M-02	Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
A 496-02	Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
A 497/A 497M-02	Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
A 615/A 615M-04b	Standard Specification for Deformed and Carbon Steel Bars for Concrete Reinforcement
A 706/A 706M-04b	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
A 722/A 722M-98 (2003)	Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete
A 767/ A 767M-00b	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A 775/ A 775M-04a	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
A 779/A 779M-00	Standard Specification for Steel Strand, Seven-Wire, Uncoated, Compacted, Stress-Relieved for Prestressed Concrete
A 780-01	Standard Practice for Repair of Damaged Hot-Dip Galvanized Coatings
A 882/A 882M-04a	Standard Specification for Filled Epoxy-Coated Seven-Wire Prestressing Steel Strand
A 884/A 884M-04	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
A 934/A 934M-04	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
A 955/ A 955M-04a^{e1}	Standard Specification for Deformed and Plain Stainless Steel Bars for Concrete Reinforcement
A 970/ A 970M-04a^{e1}	Standard Specification for Welded or Forged Headed Bars for Concrete Reinforcement
A 996/A 996M-04	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
C 31/C 31M-03a	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 33-03	Standard Specification for Concrete Aggregates
C 39/C 39M-03	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 42/ C 42M-04	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 94/C 94M-04	Standard Specification for Ready-Mixed Concrete
C 138/C 138M-01a	Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
C 143/ C143M-03	Standard Test Method for Slump of Hydraulic-Cement Concrete
C 150-04a	Standard Specification for Portland Cement
C 171-03	Standard Specification for Sheet Materials for Curing Concrete
C 172-04	Standard Practice for Sampling Freshly Mixed Concrete
C 173/ C 173M-01^{e1}	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C 192/C 192M-02	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
C 231-04	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 260-01	Standard Specification for Air-Entraining Admixtures for Concrete
C 309-03	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 330-04	Standard Specification for Lightweight Aggregates for Structural Concrete

C 387-04	Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
C 404-03	Standard Specification for Aggregates for Masonry Grout
C 494/C 494-04	Standard Specification for Chemical Admixtures for Concrete
C 567-04	Standard Test Method for Determining Density of Structural Lightweight Concrete
C 595-03	Standard Specification for Blended Hydraulic Cements
C 597-02	Standard Test Method for Pulse Velocity Through Concrete
C 618-03	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C 684-99 (2003)	Standard Test Method for Making, Accelerated Curing, and Testing Concrete Compression Test Specimens
C 685/C 685M-01	Standard Specification for Concrete Made By Volumetric Batching and Continuous Mixing
C 803/C 803M-03	Standard Test Method for Penetration Resistance of Hardened Concrete
C 805-02	Standard Test Method for Rebound Number of Hardened Concrete
C 845-04	Standard Specification for Expansive Hydraulic Cement
C 873-04	Standard Test Method for Compressive Strength of Concrete Cylinders Cast in Place in Cylindrical Molds
C 878-03	Standard Test Method for Restrained Expansion of Shrinkage-Compensating Concrete
C 881/C 881M-02	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
C 900-01	Standard Test Method for Pullout Strength of Hardened Concrete
C 928-00	Standard Specification for Packaged, Dry, Rapid Hardening Cementitious Materials for Concrete Repairs
C 939-02	Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
C 989-04	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
C 1017/ C 1017M-03	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
C 1012-04	Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
C 1059-99	Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
C 1064/ C 1064M-04	Standard Test Methods for Temperature of Freshly Mixed Portland Cement Concrete
C 1074-04	Standard Practice for Estimating Concrete Strength by the Maturity Method
C 1077-02	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
C 1107-02	Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink)
C1157-03	Standard Performance Specification for Hydraulic Cement
C 1218/ C 1218M-99	Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
C 1240-04	Standard Specification for Silica Fume Used in Cementitious Mixtures
C 1315-03	Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
C 1602/ C 1602M-04	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
D 98-98	Standard Specification for Calcium Chloride
D 994-98 (2003)	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
D 1621-04	Standard Test Methods for Compressive Properties of Rigid Cellular Plastics
D 1751-99	Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
D 1752-04	Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
D 3575-00^{e1}	Standard Test Methods for Flexible Cellular Materials Made from Olefin Polymers
E 329-03	Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
E 1155-96(2001)	Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers

1.3.1.3 *Other referenced standards*—Other standards referenced in this Specification:

ANSI/ AWS D1.4-98	Structural Welding Code—Reinforcing Steel
CRD-C 513-74	Specification for Rubber Waterstops
CRD-C 572-74	Specification for Polyvinyl chloride Waterstops

1.3.2 *Cited publications*—Publications cited in this Specification:

ACI 318-05	Building Code Requirements for Structural Concrete
ACI CP1-04	ACI Certification Concrete Field Testing Technician—Grade I
ACI CP10-95	ACI Certification Flatwork Technician and Flatwork Finisher
ACI SP-15	Field Reference Manual: Specifications for Structural Concrete (ACI 301-05) with Selected ACI and ASTM References
CRSI MSP-2-01	Manual of Standard Practice, 27th Edition, Voluntary Certification Program for Fusion-Bonded Epoxy Coating Applicator Plants

1.3.3 *Field references*—Keep in Contractor's field office a copy of the following reference:

ACI SP-15	Field Reference Manual: Specifications for Structural Concrete (ACI 301-05) with Selected ACI and ASTM References.

1.4—Standards-producing organizations

Abbreviations for and complete names and addresses of organizations issuing documents referred to in this Specification are listed:

American Concrete Institute (ACI)
P.O. Box 9094
Farmington Hills, MI 48333-9094

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428

American Welding Society (AWS)
550 Northwest 42nd Avenue
Miami, FL 33126

Concrete Reinforcing Steel Institute (CRSI)
933 N. Plum Grove Road
Schaumburg, IL 60173

U.S. Army Corps of Engineers [COE(CRD)]
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180

National Ready Mixed Concrete Association (NRMCA)
900 Spring Street
Silver Spring, MD 20910

1.5—Submittals

1.5.1 *General*—Unless otherwise specified, submittals required in this Specification shall be submitted for review and acceptance.

1.5.2 *Testing agency reports*—Testing agencies will report results of concrete and concrete materials tests and inspections performed during the course of the Work to the Owner, Architect/Engineer, Contractor, and the concrete supplier. Strength test reports will include location in the Work where the batch represented by test was deposited and the batch ticket number. Reports of strength tests will include detailed information of storage and curing of specimens before testing. Final reports will be provided within seven days of test completion.

1.6—Quality assurance

1.6.1 *General*—Concrete materials and operations may be tested and inspected by the Owner as work progresses. Failure to detect defective work or material will not prevent rejection if a defect is discovered later nor shall it obligate the Architect/Engineer for final acceptance.

1.6.2 *Testing agencies*—Agencies that test concrete materials shall meet the requirements of ASTM C 1077. Testing agencies that test reinforcing steel shall meet the requirements of ASTM E 329. Testing agencies shall be accepted by the Architect/Engineer before performing any work. Field tests of concrete required in 1.6.3 and 1.6.4 shall be made by an ACI Concrete Field Testing Technician Grade 1 certified in accordance with ACI CP1 or equivalent. Equivalent certification programs shall include requirements for written and performance examinations as stipulated in ACI publication CP1.

1.6.3 *Testing responsibilities of Contractor*

1.6.3.1 Submit data on qualifications of proposed testing agency for acceptance. Use of testing services will not relieve the Contractor of the responsibility to furnish materials and construction in compliance with the Contract Documents.

1.6.3.2 *Duties and responsibilities*—Unless otherwise specified in the Contract Documents, the Contractor shall assume the duties and responsibilities given in 1.6.3.2.a through 1.6.3.2.g:

1.6.3.2.a Qualify proposed materials and establish mixture proportions.

1.6.3.2.b Allow access to the project site or to the source of materials and assist Owner's testing agency in obtaining and handling samples at the project site or at the source of materials.

1.6.3.2.c Advise Owner's testing agency at least 24 h in advance of operations to allow for completion of quality tests and for assignment of personnel.

1.6.3.2.d Provide and maintain adequate facilities on the project site for safe storage and initial curing of concrete test specimens as required by ASTM C 31/C 31M for the sole use of the testing agency.

1.6.3.2.e Submit test data and documentation on concrete ingredient materials and mixture proportions.

1.6.3.2.f Submit quality-control program of the concrete supplier and provide copies of test reports pertaining to the Work.

1.6.3.2.g When specified or permitted to base concrete acceptance on accelerated strength testing, submit correlation data for the standard 28-day compressive strength based on at least 15 sets of test data in accordance with 1.6.4.2.e with concrete made with the same materials encompassing a range of at least the required average strength f'_{cr}, plus or minus 1000 psi.

1.6.3.3 *Tests required of Contractor's testing agency*—Unless otherwise specified in the Contract Documents, the

Contractor shall provide, at no cost to the Owner, the necessary testing services given in 1.6.3.3.a and 1.6.3.3.b:

1.6.3.3.a Qualification of proposed materials and establishment of concrete mixtures.

1.6.3.3.b Other testing services needed or required by Contractor.

1.6.4 *Testing responsibilities of Owner's testing agency*

1.6.4.1 Unless otherwise specified in the Contract Documents, the Owner's testing agency will provide the necessary services given in 1.6.4.1.a through 1.6.4.1.c:

1.6.4.1.a Representatives of the Owner's testing agency will inspect, sample, and test materials and production of concrete as required by the Architect/Engineer. When it appears that material furnished or work performed by the Contractor fails to conform to Contract Documents, the testing agency will immediately report such deficiency to the Architect/Engineer, Contractor, and concrete supplier.

1.6.4.1.b The testing agency and its representatives are not authorized to revoke, alter, relax, enlarge, or release any requirement of the Contract Documents, nor to accept or reject any portion of the Work.

1.6.4.1.c The testing agency will report test and inspection results that pertain to the Work to the Architect/Engineer, Contractor, and concrete supplier within seven days after tests and inspections are performed.

1.6.4.2 *Testing services*—When required by the Owner or the Architect/Engineer, the Owner's testing agency will perform the following testing services given in 1.6.4.2.a through 1.6.4.2.i at no cost to the Contractor:

1.6.4.2.a Review and check-test proposed materials for compliance with Contract Documents.

1.6.4.2.b Review and check-test proposed concrete mixture as required by the Architect/Engineer.

1.6.4.2.c Obtain production samples of materials at plants or stockpiles during the course of the Work and test for compliance with the Contract Documents.

1.6.4.2.d Obtain samples in accordance with ASTM C 172. Select the truckloads or batches of concrete to be tested on a random basis, using random numbers selected before commencement of concrete placement.

Obtain at least one composite sample for each 100 yd^3, or fraction thereof, of each concrete mixture placed in any one day. When the total quantity of a given concrete mixture is less than 50 yd^3, the strength tests may be waived by the Architect/Engineer.

1.6.4.2.e Conduct concrete strength tests during construction in accordance with the following procedures:

- Mold and cure a minimum of three cylinders from each sample in accordance with ASTM C 31/C 31M. Record any deviations from the ASTM requirements in the test report.
- Test cylinders in accordance with ASTM C 39/C39M. Test one specimen at seven days for information, and test a minimum of two specimens at 28 days for acceptance, unless otherwise specified. The compressive strength test results for acceptance shall be the average of the compressive strengths from the specimens tested at 28 days. If a specimen in a test shows evidence of improper sampling, molding, or testing, discard the specimen and consider the strength of the remaining cylinder or cylinders to be the test result. If all specimens in a test show defects, discard the entire test.
- When accelerated testing of concrete is specified or permitted as an alternative to standard testing, mold and cure two specimens from each composite sample in accordance with ASTM C 684, following the procedure specified by the Architect/Engineer. Make at least one accelerated strength test from each composite sample in 1.6.4.2.d and one standard cured 28-day compressive-strength test for at least every other accelerated strength test in accordance with ASTM C 31/C 31M. Use these test results to maintain and update the correlation between accelerated and standard 28-day compressive-strength tests.

1.6.4.2.f Determine slump of each composite sample taken in accordance with 1.6.4.2.d and whenever consistency of concrete appears to vary, using ASTM C 143/C 143M.

1.6.4.2.g Determine the temperature of each composite sample taken in accordance with 1.6.4.2.d using ASTM C 1064/C1064M.

1.6.4.2.h Determine the air content of normalweight concrete using ASTM C 231, C 173, or C 138 for each composite sample taken in accordance with 1.6.4.2.d or as directed by the Architect/Engineer. Additional tests may be performed as necessary.

1.6.4.2.i When the Contract Documents indicate concrete will be exposed to deicing salts, air content tests will be made on samples from the first three batches in the placement and until three consecutive batches have air contents within the range specified in 4.2.2.4, at which time every fifth batch will be tested. This test frequency will be maintained until a batch is not within the range specified in 4.2.2.4, at which time testing of each batch will be resumed until three consecutive batches have air contents within the range specified in 4.2.2.4. Additional tests may be performed as necessary for control. These air content tests may be taken on composite samples in 1.6.4.2.d or on samples from the batch at any time after discharge of 2 ft^3 of concrete.

1.6.4.3 *Additional testing services*—When required by the Architect/Engineer, the Owner's testing agency will perform the following testing services at no cost to the Contractor:

- Inspect the concrete batching, mixing, and delivery operations;
- Inspect forms, foundation preparation, reinforcing steel, embedded items, reinforcing steel placement, and concrete placing, finishing, and curing operations;
- Sample concrete at point of placement and other locations as directed by the Architect/Engineer and perform required tests;
- Review the manufacturer's report for each shipment of cement, reinforcing steel, and prestressing tendons, and conduct laboratory tests or spot checks of the materials received for compliance with specifications; and
- Other testing or inspection services as required by the Architect/Engineer.

1.6.4.4 *Other testing services as needed*—The Contractor shall pay for the following testing services performed, when necessary, by the Owner's testing agency:

- Additional testing and inspection required because of changes in materials or mixture proportions requested by the Contractor; and
- Additional testing of materials or concrete occasioned by failure to meet specification requirements.

1.6.5 *Tests on hardened concrete in-place*

1.6.5.1 *General*—When needed, tests on hardened concrete will be performed by the Owner's testing agency. Testing shall be at the Contractor's expense when this Specification requires such tests to verify the strength of the structure. The Owner will pay costs if tests are at the Owner's request and not required by this Specification.

1.6.5.2 *Nondestructive tests*—Use of the rebound hammer in accordance with ASTM C 805, pulse-velocity method in accordance with ASTM C 597, or other nondestructive tests may be permitted by the Architect/Engineer for evaluating the uniformity and relative concrete strength in place, or for selecting areas to be cored.

1.6.5.3 *Core tests*

1.6.5.3.a Where required by the Architect/Engineer, obtain cores in accordance with ASTM C 42/C42 M. Wipe cores surface-dry immediately after coring and allow to dry in air for a period not exceeding one hour after drilling. Seal cores in plastic bags or nonabsorbent containers until testing. End preparation of cores shall be completed within 48 h after drilling. Test cores not earlier than 48 h after drilling or last wetting and not later than seven days after the cores were drilled from the structure.

1.6.5.3.b At least three representative cores shall be taken from each area of in-place concrete that is considered potentially deficient. The location of cores shall be determined by the Architect/Engineer to impair the strength of the structure as little as possible. If, before testing, cores show evidence of having been damaged subsequent to or during removal from the structure, replacement cores shall be taken.

1.6.5.3.c Fill core holes with low-slump concrete or mortar of a strength equal to or greater than the original concrete.

1.6.6 *Evaluation of concrete strength tests*

1.6.6.1 *Standard molded and cured strength specimens*—Test results from standard molded and cured test cylinders shall be evaluated separately for each specified concrete mixture. Evaluation will be valid only if tests have been conducted in accordance with procedures specified. For evaluation, each specified mixture shall be represented by at least five tests.

1.6.6.2 *Nondestructive tests*—Test results will be evaluated by the Architect/Engineer and will be valid only if tests have been conducted using properly calibrated equipment in accordance with recognized standard procedures and an acceptable correlation between test results and concrete compressive strength has been established and is submitted.

1.6.6.3 *Core tests*—Core test results will be evaluated by the Architect/Engineer and will be valid only if tests have been conducted in accordance with specified procedures.

1.6.7 *Acceptance of concrete strength*

1.6.7.1 *Standard molded and cured strength specimens*—The strength level of concrete will be considered satisfactory when: the averages of all sets of three consecutive compressive strength test results molded and cured in accordance with the requirements of ASTM C 31/C 31M equal or exceed f'_c; and no individual strength test result falls below f'_c by more than 500 psi when f'_c is 5000 psi or less, or by more than $0.10f'_c$ when f'_c is more than 5000 psi. These criteria also apply to accelerated strength testing unless another basis for acceptance is specified in the Contract Documents.

1.6.7.2 *Nondestructive tests*—Nondestructive tests shall not be used as the sole basis for accepting or rejecting concrete, but may be used, when permitted, to evaluate concrete where standard molded and cured cylinders have yielded results not meeting the criteria in 1.6.7.1.

1.6.7.3 *Core tests*—Strength level of concrete in the area represented by core tests will be considered adequate when the average compressive strength of the cores is equal to at least 85% of f'_c, and if no single core is less than 75% of the specified compressive strength f'_c.

1.6.8 *Field acceptance of concrete*

1.6.8.1 *Air content*—Concrete not within the limits of air-entrainment indicated in 4.2.2.4 and tested in accordance with 1.6.4.2.h shall not be used in the Work.

1.6.8.2 *Slump*—Concrete not within the slump limits of 4.2.2.2 shall not be used in the Work.

1.6.8.3 *Temperature*—Concrete not within temperature limits of 4.2.2.8 shall not be used in the Work.

1.7—Acceptance of structure

1.7.1 *General*—Completed concrete work shall conform to applicable requirements of this Specification and the Contract Documents.

1.7.1.1 Concrete work that fails to meet one or more requirements of the Contract Documents but subsequently is repaired to bring the concrete into compliance will be accepted.

1.7.1.2 Concrete work that fails to meet one or more requirements of the Contract Documents and cannot be brought into compliance may be rejected.

1.7.1.3 Repair rejected concrete work by removing and replacing or by reinforcing with additional construction as required by the Architect/Engineer. To bring rejected work into compliance, use repair methods that will maintain specified strength and meet applicable requirements for function, durability, dimensional tolerances, and appearance as determined by the Architect/Engineer.

1.7.1.4 Submit for acceptance the proposed repair methods, materials, and modifications needed to repair the concrete work to meet the requirements of Contract Documents.

1.7.1.5 Contractor shall pay all costs to bring concrete work into compliance with requirements of Project Specification.

1.7.1.6 Concrete members cast in the wrong location may be rejected.

1.7.2 *Dimensional tolerances*

1.7.2.1 Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of ACI 117 may be

considered deficient in strength and subject to the provisions of 1.7.4.

1.7.2.2 Formed surfaces resulting in concrete outlines larger than permitted by ACI 117 may be rejected. Remove excess materials when required by the Architect/Engineer.

1.7.2.3 Inaccurately formed concrete surfaces that exceed ACI 117 tolerances may be rejected.

1.7.2.4 Finished slabs exceeding the tolerances in 5.3.4.3 may be corrected provided they are brought into compliance with 1.7.3, 1.7.4, and 1.7.5.

1.7.2.5 Concrete with tolerances and defects exceeding the limitations of 2.2.2.4 may be rejected.

1.7.3 *Appearance*

1.7.3.1 Concrete not meeting the requirements of 5.3.3 or 5.3.4 shall be brought into compliance in accordance with 1.7.1.

1.7.4 *Strength of structure*

1.7.4.1 *Criteria for determining potential strength deficiency*—Strength will be considered deficient and concrete work will be rejected when the work fails to comply with requirements that control the strength of the structure including, but not limited to, the conditions given in 1.7.4.1.a through 1.7.4.1.f:

1.7.4.1.a Concrete strength failing to comply with requirements of 1.6.7.

1.7.4.1.b Reinforcing steel size, quantity, grade, position, or arrangement at variance with the requirements of Section 3 or other Contract Documents.

1.7.4.1.c Concrete elements that differ from the required dimensions or location.

1.7.4.1.d Curing not performed in accordance with Contract Documents.

1.7.4.1.e Inadequate protection of concrete from extreme temperature and other adverse environmental conditions during early stages of hardening and strength development.

1.7.4.1.f Mechanical injury, construction fires, or premature removal of formwork resulting in deficient strength.

1.7.4.2 *Action required when strength is potentially deficient*—When strength of the structure is considered potentially deficient, the actions given in 1.7.4.2.a through 1.7.4.2.e may be required by the Architect/Engineer:

1.7.4.2.a Structural analysis or additional testing, or both.

1.7.4.2.b Core tests.

1.7.4.2.c If testing is inconclusive or impractical or if structural analysis does not confirm the safety of the structure, load tests may be required and their results evaluated in accordance with ACI 318.

1.7.4.2.d Concrete work rejected by structural analysis or by results of a load test shall be strengthened with additional construction when required by the Architect/Engineer, or replaced.

1.7.4.2.e Document all repair work proposed to bring strength-deficient concrete work into compliance with Contract Documents, and submit the documentation to the Architect/Engineer for acceptance.

1.7.5 *Durability*

1.7.5.1 *Criteria for determining potential durability deficiency*—Durability of concrete work will be considered deficient and the concrete work will be rejected when it fails to comply with the requirements that control durability of the structure, including, but not limited to, the conditions given in 1.7.5.1a through 1.7.5.1.f:

1.7.5.1.a Strength failing to comply with 1.6.7.

1.7.5.1.b Materials for concrete not conforming to the requirements in 4.2.1.1, 4.2.1.2, 4.2.1.3, and 4.2.1.4.

1.7.5.1.c Concrete not conforming to the air-entrainment requirements in Contract Documents or the air content limits of Table 4.2.2.4.

1.7.5.1.d Curing not in accordance with Contract Documents.

1.7.5.1.e Inadequate protection of concrete from detrimental temperature and other detrimental environmental conditions during early stages of hardening and strength development.

1.7.5.1.f Concrete exceeding the maximum allowable chloride-ion content requirements in Table 4.2.2.6.

1.7.5.2 *Action required when durability is potentially deficient*—When durability of the structure is considered to be potentially deficient, the actions given in 1.7.5.2.a through 1.7.5.2.e may be required by the Architect/Engineer:

1.7.5.2.a Obtain and test samples of the ingredient materials used in the concrete.

1.7.5.2.b Obtain samples of concrete from the structure by coring, sawing, or other acceptable means.

1.7.5.2.c Laboratory evaluation of concrete and concrete materials to assess the ability of concrete to resist weathering action, chemical attack, abrasion, or other deterioration, and to protect reinforcement and embedments from corrosion.

1.7.5.2.d Repair or replace concrete rejected for durability deficiency as directed by the Architect/Engineer.

1.7.5.2.e Document repair work to bring concrete work into compliance with Contract Documents and submit the documentation to the Architect/Engineer for acceptance.

1.8—Protection of in-place concrete

1.8.1 *Loading and support of concrete*—Do not allow construction loads to exceed the superimposed load that the structural member, with necessary supplemental support, is capable of supporting safely and without damage or unacceptable deflections.

1.8.2 *Protection from mechanical injury*—During the curing period, protect concrete from damaging mechanical disturbances, including load-induced stresses, shock, and harmful vibration. Protect concrete surfaces from damage by construction traffic, equipment, materials, rain or running water, and other adverse weather conditions.

SECTION 2—FORMWORK AND FORMWORK ACCESSORIES

2.1—General

2.1.1 *Description*—This section covers design, construction, and treatment of formwork to confine and shape concrete to the required dimensions.

NOTES TO SPECIFIER:

FOREWORD TO CHECKLISTS

F1. This Foreword is included for explanatory purposes only; it does not form a part of Specification ACI 301.

F2. ACI Specification 301 may be referenced by the Specifier in the Project Specification for any building project, together with supplementary requirements for the specific project. Responsibilities for project participants must be defined in the Project Specification. The ACI Specification cannot and does not address responsibilities for any project participant other than the Contractor.

F3. Checklists do not form a part of ACI Specification 301. Checklists assist the Specifier in selecting and specifying project requirements in the Project Specification.

F4. Building codes set minimum requirements necessary to protect the public. ACI Specification 301 may stipulate requirements more restrictive than the minimum. The Specifier shall make adjustments to the needs of a particular project by reviewing each of the items in the checklists and including those the Specifier selects as mandatory requirements in the Project Specification.

F5. The Mandatory Requirements Checklist indicates work requirements regarding specific qualities, procedures, materials, and performance criteria that are not defined in ACI Specification 301.

F6. The Optional Requirements Checklist identifies Specifier choices and alternatives. The checklists identify the Sections, Parts, and Articles of the reference specification and the action required or available to the Specifier.

F7. *Recommended References*—Documents and publications that are referenced in the Checklists of ACI Specification 301 are listed. These references provide guidance to the Specifier and are not considered to be part of ACI Specification 301.

American Concrete Institute (ACI)

ACI 117R	Commentary on Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 201.2R	Guide to Durable Concrete
ACI 207.2R	Effect of Restraint, Volume Change, and Reinforcement on Cracking of Mass Concrete
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 222R	Protection of Metals in Concrete Against Corrosion
ACI 223	Standard Practice for the Use of Shrinkage Compensating Concrete
ACI 225R	Guide to the Selection and Use of Hydraulic Cements
ACI 228.1R	In-Place Methods to Estimate Concrete Strength
ACI 302.1R	Guide for Concrete Floor and Slab Construction
ACI 303R	Guide to Cast-In-Place Architectural Concrete Practice
ACI 303.1	Standard Specification for Cast-In-Place Architectural Concrete
ACI 305R	Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308.1	Standard Practice for Curing Concrete
ACI 311.1R	ACI Manual of Concrete Inspection—SP-2 (99)
ACI 311.4R	Guide for Concrete Inspection
ACI 311.5R	Guide for Plant Inspection and Field Testing of Ready-Mixed Concrete
ACI 318	Building Code Requirements for Structural Concrete (ACI 318-05) and Commentary (318R-05)
ACI 347	Guide to Formwork for Concrete
ACI CP 10	Craftsman Workbook for ACI Certification of Concrete Flat Work Technician/Finisher

ASTM International

ASTM C 441	Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/ft^3 (600 kN-m/m^3)]
ASTM D 1557	Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)]

National Ready Mixed Concrete Association (NRMCA)

Quality Control Manual, Section 3—Certification of Ready Mixed Concrete Production Facilities

Portland Cement Association (PCA)

PCA Design and Control of Concrete Mixtures, 14th Edition

Wire Reinforcement Institute (WRI)

WRI Manual of Standard Practice

Guidance for evaluating the degree of rusting on strand is given in "Evaluation of Degree of Rusting on Prestressed Concrete Strand," by A. S. Sason, *PCI Journal*, V. 37, No. 3, May-June 1992, pp. 25-30.

The above publications may be obtained from the following organizations (additional references can be found in Section 1.3 of the Specification):

American Concrete Institute (ACI)
P.O. Box 9094
Farmington Hills, MI 48333-9094

ASTM International
100 Barr Harbor Dr.
West Conshohocken, PA 19428

National Ready Mixed Concrete Association
90 Spring St.
Silver Spring, MD 20910

Prestressed Concrete Institute
209 W. Jackson Blvd Ste. 500
Chicago, IL 60606

Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60076

Wire Reinforcement Institute, Inc.
942 Main St., Suite 300
Hartford, CT 06103

OPTIONAL REQUIREMENTS CHECKLIST

Section/Part/Article	Notes to Architect/Engineer
General requirements	
1.6.3.2, 1.6.3.3, 1.6.4.1	Specify if other testing arrangements are required, such as Owner's testing agency establishing mixture proportions or any testing responsibilities of the Owner's testing agency that will be performed by the Contractor's testing agency.
1.6.3.2.g, 1.6.4.2.e	If accelerated testing of concrete is specified or permitted as an alternative to standard testing, specify the procedure from ASTM C 684 that is to be followed. Specify when compressive test specimens are to be tested if other than seven and 28 days.
1.6.4.3	Specify additional testing services desired for the Work, if applicable. Note that these additional testing services are to be performed by the Owner's testing laboratory; hence, the term "will" is used in place of "shall" in 1.6.4.3. Refer to ACI 311.1R (SP-2), ACI 311.4R, and 311.5R for specific inspection items that may be appropriate. When it is necessary or desirable to know properties of concrete at the point of placement or at locations other than the delivery point, specify that concrete is to be sampled at these other locations for testing. See the discussion under Optional Requirements in Section 4.2.2.2.
1.6.5.2	Specify if nondestructive tests will be permitted to evaluate uniformity or relative in-place strength of concrete. Refer to ACI 228.1R for guidance on nondestructive test methods.
1.6.7.1	If another basis for acceptance of concrete strength level is required for accelerated strength testing, specify the basis for acceptance.
Formwork and formwork accessories	
2.1.2.1	Review the list of submittal items and specify in Contract Documents the items that need not be submitted.
2.1.2.2	Review the list of submittal items and specify in Contract Documents the items to be submitted.
2.2.1.1	Specify other materials for form faces in contact with concrete.
2.2.1.2	Indicate where walls require form ties with a positive water-barrier.
2.2.2.1	Specify if calculations and drawings for formwork must be sealed by a licensed Engineer.
2.2.2.3	Specify if earth cuts will be permitted or required.
2.2.2.4	Specify more or less stringent limitations on deflection of facing materials when needed. Refer to ACI 347 for further guidance.
2.2.2.5.b	Specify or allow alternative locations for formed construction joints when necessary to facilitate formwork removal or accelerate construction, provided that the alternative joint locations do not adversely affect the strength of the structure.
2.2.2.5.c	Specify keyway depths other than 1-1/2 in. when required.
2.2.3.2	Specify if chamfer strips are not required on exterior corners of permanently exposed surfaces. Specify if bevels are required on re-entrant corners of concrete or on edges of formed concrete joints.
2.3.1.2	Specify tolerance limits required to be different than those of ACI 117. Specify when a more or less restrictive tolerance for abrupt offset is required. Refer to ACI 347 and the Commentary to ACI 117 for further guidance.
2.3.2.5	Specify the minimum compressive strength for removal of forms supporting the weight of concrete if different than f'_c. Specify if nonload-carrying form-facing material is not permitted to be removed at an earlier age than the load-carrying portion of the formwork.
2.3.4.2	Specify if the alternative methods for evaluating concrete strength for formwork removal are permitted.
Reinforcement and reinforcement supports	
3.1.1	Specify if the submittals listed in 3.1.1.1 through 3.1.1.3 are not required to be submitted. Otherwise, they will be required to be submitted.
3.2.1.1	For headed bars, specify type of steel for reinforcing bars: • Low-alloy steel (ASTM A 706/A 706M); • Carbon steel (ASTM A 615/A 615M). For carbon steel (ASTM A 615/A 615M) also specify grade; and • Rail steel or axle steel deformed bars (ASTM A 996/A 996M).
3.2.1.2	Specify if coated reinforcing bars are required and, if so, whether the coating is to be zinc or epoxy.
3.2.1.2.a	For zinc-coated reinforcing bars conforming to ASTM A 767/A 767M, specify the class of coating, whether galvanizing is to be performed before or after fabrication, and indicate which bars require special finished bend diameters (usually smaller sizes used for stirrup and ties). Avoid mixing galvanized and nongalvanized reinforcing steel or other embedded steel that could result in galvanic cells.
3.2.1.2.b	Specify the ASTM specification to which epoxy-coated reinforcing bars are to conform.
3.2.1.4	Specify which of the three combinations will apply.
3.2.1.5	Specify plain or deformed wire and, if required, epoxy-coated wire.

SUBMITTALS CHECKLIST

NOTE: The items listed will be submitted by the Contractor and reviewed by the Architect/Engineer.

Notify the Contractor of acceptance or rejection after review of submittals. All submittals and responses should be retained in files for future reference during the Work. Some submittal requirements shown will apply only when optional requirements are selected and written into the Project Specifications. Once optional requirements have been selected, review the Section/Part/Article indicated for the submittal item to see if it applies.

Section/Part/Article	Submittal items and notes to Architect/Engineer
General requirements	
1.6.3.1	Proposed testing agency.
1.6.3.2.e	Test data and documentation on materials and concrete mixtures.
1.6.3.2.f	Quality-control program of the concrete supplier.
1.6.3.2.g	Request to use accelerated testing and correlation data.
1.6.4.1.c	Test and inspection results.
1.7.1.4	Proposed repair methods, materials, and modifications to the Work.
1.7.4.2.e	Description of repair work performed to bring strength-deficient concrete into compliance with the Contract Documents.
1.7.5.2.e	Description of repair performed to bring potentially nondurable concrete into compliance with the Contract Documents.
Formwork and formwork accessories	
2.1.2.1.a	Data on formwork facing materials if different from that specified in 2.2.1.1.
2.1.2.1.b	Data on proposed departure from location or detail of construction and contraction joints shown on the project drawings.
2.1.2.1.c	Correlation data for alternative methods of determining strength of concrete for formwork removal. Refer to ACI 228.1R for recommendations on developing suitable correlation data.
2.1.2.1.d	Detailed plan for formwork removal at a lower compressive strength than specified.
2.1.2.1.e	Plan and procedures for installation and removal of reshoring and backshoring. See ACI 347 for guidance on items to consider.
2.1.2.1.f	Data on formwork release agent or formwork liners.
2.1.2.2.a	Shop drawings for formwork.
2.1.2.2.b	Calculations for formwork, reshoring, and backshoring.
2.1.2.2.c	Data and samples of form ties.
2.1.2.2.d	Data and samples of expansion joint materials.
2.1.2.2.e	Data and samples of waterstops.
2.2.2.3	Request to use earth cuts as form surfaces.
2.2.2.5.b	Alternative location and details of construction joints.
2.2.2.5.d	Alternative locations and details for formed construction and contraction joints.
2.3.2.5	Detailed plan for formwork removal at a lower compressive strength than f_c'.
2.3.4.2	Data correlating alternative concrete strength-measuring methods for formwork removal. Refer to ACI 228.1R for recommendations on developing suitable correlation data.
Reinforcement and reinforcement supports	
3.1.1.1.a	Certified test reports on materials.
3.1.1.1.b	Placing drawings showing fabrication dimensions and locations for placement of reinforcement and supports.
3.1.1.1.c	List of splices and request to use splices not shown on the project drawings.
3.1.1.1.d	Request to use mechanical splices not shown on the project drawings.
3.1.1.1.e	Request for placement of column dowels without the use of templates.
3.1.1.1.f	Request and procedure to field bend or straighten partially embedded reinforcement.
3.1.1.1.g	Copy CRSI Plant Certification.
3.1.1.2.a	Description of reinforcement weld locations, weld procedures, and welder qualifications.
3.1.1.2.b	Proposed supports for coated reinforcement and materials for fastening coated reinforcement not covered in 3.3.2.4.
3.1.1.3.a, 3.3.2.2	When the Contractor finds it necessary to move reinforcement beyond the specified placing tolerances to avoid interference with other reinforcement, conduits, or embedded items, review a submittal showing the resulting arrangement of reinforcement.

Exhibit 5
ACI 301-A Meeting Kansas City

ACI 301 Suggested sections for review by Colin Lobo

1.1.2

See definitions for:

- High early strength concrete
- Lightweight concrete – see structural light weight concrete too
- Mass concrete – should min dimension be stated?
- Permitted and required

General – should all references to “contract documents” include a note to the A/E to specify something? How are these sections useful when 301 is invoked by general reference?
1.6.3.2.a – is this the contractor’s responsibility?
1.6.3.2.e – is this the contractor’s responsibility?
1.6.3.2.f – what is an appropriate quality control program?
1.6.3.2.g – is this the contractor’s responsibility?

1.6.3.3.b- should this be “by the Owner”?
1.6.4.1 and subsections – change “will” to “shall”?
1.6.4.2.d – delete “using random numbers” – review testing frequency relative to 318 and C 94.
1.6.4.2.e – requirement for 3 cylinders with 7-d for info. Review C 684 – might be withdrawn by ASTM. Consider cylinder size.
1.6.4.2.? – consider measuring density for each sample.
1.6.4.2.i – review frequency of air tests.
1.6.5.3.a – defer core conditioning to C 42
1.6.8 – allow for retest.
1.7.2.5 - ??