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Preparing Activity: NASA Superseding
 NASA-03305S (December 2005)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are NOT in agreement with UMRL dated 01 April 2006

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SECTION 03 30 53.00 40

CAST-IN-PLACE CONCRETE (SHORT SECTION) 04/06

NOTE: Delete, revise, or add to the text in this section to cover project requirements. Notes are for designer information and will not appear in the final project specification.

This broadscope section covers normal-weight, portland cement concrete, including formwork, reinforcement and finishing for building and construction.

Drawings must include a complete design indicating the character of the work to be performed and giving the following:

Loading assumptions and unit stresses used in the design

Details of reinforcement, indicating reinforcing bar sizes, bends, and stopping points; details of stirrups; and location and size of welded wire fabric

Specific locations for use of the various classes of concrete when required

Details of all concrete sections showing dimensions and cover over reinforcement

Details and locations of expansion and construction joints including waterstops when required

Details and locations of isolation joints

Locations and details which require a depressed structural slab or other conditions in order to provide finished surfaces at the same elevations

Locations and details for architectural concrete when required

Location of finishes for formed surfaces, monolithic slabs, and floor topping when required

Earth fills under concrete slabs on ground are specified in Section 31 00 00.00 40 EARTHWORK.

Setting bearing plates, including bedding mortar, is specified in Section 05 12 00.00 40 STRUCTURAL STEEL, and Section 05 21 00.00 40 STEEL JOISTS.

Fire-resistance-rated construction using cast-in-place concrete is described in Underwriters Laboratories, Inc., "Fire Resistance Ratings (BXUV)" included in UL FRD, and the "Fire Resistance Ratings" contained in AIA CO-1. Fire-resistance-rated construction limits aggregate materials and concrete cover over reinforcement.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of [technical proponents](#), including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a [Criteria Change Request \(CCR\)](#).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACI INTERNATIONAL (ACI)

ACI 117	(1990; R 2002) Standard Tolerances for Concrete Construction and Materials (ACI 117-90) and Commentary (ACI 117R-90)
ACI 211.1	(1991; R 2002) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 318/318R	(2005) Building Code Requirements for Structural Concrete (ACI 318-05) and Commentary (ACI 318R-05)
ACI/MCP 205	(2005) Manual of Concrete Practice Part 2 - ACI 224R-01 to ACI 313R-97
ACI/MCP 305	(2005) Manual of Concrete Practice Part 3:315-99 to 343R-95
ACI/MCP 405	(2005) Manual of Concrete Practice Part 4:345R-91(97) to 355.2R-04

ASTM INTERNATIONAL (ASTM)

ASTM A 185	(2002) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 615/A 615M	(2005a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 1064/C 1064M	(2005) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C 143/C 143M	(2005) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 172	(2004) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2001e1) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2001) Standard Specification for

Air-Entraining Admixtures for Concrete

ASTM C 309	(2003) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2003a) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 39/C 39M	(2004) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 494/C 494M	(2005) Standard Specification for Chemical Admixtures for Concrete
ASTM C 595	(2003) Standard Specification for Blended Hydraulic Cements
ASTM C 618	(2005) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 94/C 94M	(2004a) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2005) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 990	(2003a) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C 990M	(2003a) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 2628	(1991; R 2005) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM E 1155	(1996; R 2001) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E 1155M	(1996; R 2001) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers [Metric]

1.2 GENERAL

All work shall be in accordance with [ACI/MCP 305](#) and [ACI 318/318R](#).

1.3 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings shall be provided for the following:

Concrete Placement
Forms
Steel Reinforcement
Accessories

SD-05 Design Data

Mix design data shall be submitted in accordance with the paragraph entitled, "Ready-Mix Concrete," of this section.

SD-06 Test Reports

Test reports shall be in accordance with tests as described in the paragraph entitled, "Field Testing," of this section for the following items:

Slump
Concrete
Compressive Strength Testing
Measurement of Floor Tolerances

SD-07 Certificates

Bill of Lading for Ready-Mix Concrete deliveries.

Certificates of compliance shall be provided showing conformance with referenced standards contained in this section for the following:

Proposed Ready-Mix Concrete
Fly Ash
Air-Entraining Admixtures
Steel Reinforcement
Waterstops
Curing Compound

1.4 INSTALLATION DRAWINGS

Specific locations of [Concrete Placement] [Forms] [Steel Reinforcement] [Accessories] [Expansion Joints] [Construction Joints] [Contraction Joints] [Control Joints] shall be indicated on installation drawings and shall include but not be limited to square feet of concrete placements, thicknesses and widths, plan dimensions, and arrangement of cast-in-place concrete section.

1.5 FLATNESS AND LEVELNESS OF FLOOR SLABS

1.5.1 Floor Tolerance Measurements

Floor flatness and levelness test, (FF and FL respectively), on floor slabs shall be conducted in accordance with the provisions set forth in **ASTM E 1155M ASTM E 1155**. Also Zi calculation to be used shall be $N_{min.} = A/10$.

Floor tolerance measurements shall be made by the approved laboratory and inspection service within 24 hours after completion of final troweling operation and before forms and shores have been removed, measurement shall be taken with a Dipstick Auto-Read floor profiler instrument.

Results of floor tolerance tests, including formal notice of acceptance or rejection of the work, shall be provided to the Contractor within 24 hours after data collection.

PART 2 PRODUCTS

2.1 READY-MIX CONCRETE

Concrete shall be ready-mix concrete and mix design data shall conform to **ACI/MCP 205**

Non-exposed concrete elements: 20 megapascal 3000 psi minimum compressive strength.

Direct-exposed concrete elements (including air-conditioned rooms): 34.5 megapascal 5000 psi minimum compressive strength shall be determined in 28 calendar days.

Slump: 25 millimeter 1 inch to 100 millimeter 4 inch according to ASTM C 143/C 143M and ACI 211.1.

[Portland Cement shall conform to ASTM C 150, Type [____].]

[Blended hydraulic cement shall conform to ASTM C 595, Type [____].]

One brand and type of cement shall be used for formed concrete having exposed-to-view finished surfaces.

Air-Entraining Admixtures shall conform to ASTM C 260. [Exterior concrete exposed to freezing shall be air-entrained 5 to 6 percent by volume. Nonair-entrained interior concrete shall have total air content of 2 to 4 percent by volume.]

Water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and accelerating admixtures, and water-reducing and retarding admixtures shall conform to ASTM C 494/C 494M.

Fly Ash [is required] [used] as an admixture [and] shall conform to ASTM C 618, Class [C or F] with 4 percent maximum loss on ignition and 35 percent maximum cement replacement by weight.

NOTE: Ground granulated blast furnace slag and fly ash are materials listed in the EPA's Comprehensive Procurement Guidelines (CPG) (<http://www.epa.gov/cpg/>). If the Architect/Engineer determines that use of certain materials meeting the CPG content standards and guidelines would result in inadequate competition, do not meet quality/ performance specifications, are available at an unreasonable price or are not available within a reasonable time frame, the Architect/ Engineer may submit written justification and supporting documentation for not procuring designated items containing recovered material. Written justification may be submitted on a Request for Waiver Form to the NASA Environmental Program Manager for approval. The Request for Waiver Form is located in the NASA Procedures and Guidelines (NPG 8830.1) (<http://nodis3.gsfc.nasa.gov>).

Ground granulated blast furnace slag [is required] [used] as an admixture [and] shall conform to ASTM C 989, Grade [120] with between 25 to 50 percent maximum cement replacement by weight.

2.2 STEEL REINFORCEMENT

2.2.1 Deformed Steel Bars

Steel bars shall conform to ASTM A 615/A 615M, Grade [60 ksi] [_____] ACI/MCP 305 and ACI 318/318R.

2.2.2 Welded Wire Fabric

Welded wire fabric shall conform to ASTM A 185.

2.3 FORMS

Forms shall be of wood, steel, or other approved material and shall conform to ACI/MCP 305 and ACI 318/318R.

Form release shall conform to ACI/MCP 405.

2.4 ACCESSORIES

2.4.1 Waterstops

Waterstops shall be the flat dumbbell type not less than 5 millimeter 3/16-inch thick for widths up to 125 millimeter 5 inches and not less than 10 millimeter 3/8-inch thick for widths 125 millimeter 5 inches and over.

[Waterstops shall be made of rubber and shall conform to ASTM D 1752.]

[Waterstops shall be made of polyvinylchloride (PVC) and shall conform to [ASTM C 990M ASTM C 990] [ASTM D 2628.]]

2.4.2 Chemical Floor Hardener

Hardener shall be a colorless aqueous solution containing a blend of magnesium fluorosilicate and zinc fluorosilicate combined with a wetting agent. Solution shall contain not less than 120 gram of fluorosilicates per liter (approximate 0.5 kilogram per 4 liter) 2 pounds of fluorosilicates per gallon. An approved proprietary chemical hardener may be used provided hardener is delivered ready for use in manufacturer's original containers.

2.4.3 Curing Compound

Curing compound shall conform to ASTM C 309.

PART 3 EXECUTION

3.1 FORM WORK

Form work shall be in addition to ACI/MCP 305 and ACI 318/318R, ACI/MCP 205, and ACI/MCP 405.

3.1.1 Preparation of Form Surfaces

Forms shall be true to line and grade, mortar-tight, and sufficiently rigid to prevent objectionable deformation under load. Form surfaces for permanently exposed faces shall be smooth, free from irregularities, dents, sags, or holes. Exposed joints and exposed edges shall be chamfered. Internal ties shall be so arranged that when the forms are removed, the

form ties will be not less than 50 millimeter 2 inches from concrete surfaces permanently exposed to view or exposed to water on the finished structure.

3.1.2 Form Coating

Forms for exposed surfaces shall be coated with a nonstaining form release coating which shall be applied [shortly before concrete is placed.] [before the steel case is added to avoid contaminating the reinforcing steel.] Forms for unexposed surfaces may be wetted in lieu of coating immediately before the placing of concrete, except that in freezing weather form release coating shall be used.

3.1.3 Removal of Forms

Forms shall be removed carefully to prevent damage to the concrete. Forms shall not be removed before the expiration of the minimum time indicated below:

Arches, beams and deck-type slabs	144 hours
Columns and walls (lifts 4.5 meter and under)	24 hours
Columns and walls (lifts over 4.5 meter)	48 hours
Columns and walls (lifts 15 feet and under)	24 hours
Columns and walls (lifts over 15 feet)	48 hours

3.2 STEEL REINFORCING

3.2.1 General

Reinforcement shall be free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce the reinforcement's bond with the concrete.

3.2.2 Fabrication

Steel reinforcement shall be shop fabricated in accordance with ACI/MCP 305 and ACI 318/318R. Shop details and bending shall be in accordance with ACI/MCP 305 and ACI 318/318R.

3.2.3 Splicing

Splices shall be in accordance with ACI/MCP 305 and ACI 318/318R.

3.2.4 Supports

Reinforcement shall be secured in place by the use of metal or concrete supports, spacers, or ties.

3.3 EMBEDDED ITEMS

Before placing concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place. Embedded items shall be free of oil and other foreign matter such as loose coatings of rust, paint and scale. Embedding of wood in concrete will be permitted only when specifically authorized or directed.

3.4 BILL OF LADING

Bill of Lading for each ready-mix concrete delivery shall be in accordance

with ASTM C 94/C 94M.

3.5 CONCRETE CONVEYING

Concrete shall be conveyed from mixers to forms as rapidly as practical by methods that will prevent segregation or loss of ingredients.

3.6 CONCRETE PLACING

3.6.1 General Placing Requirements

Concrete shall be placed in accordance with ACI/MCP 305 ACI 318/318R.

Concrete shall be worked into the corners and angles of the forms and around reinforcement and embedded items without permitting the materials to segregate. Concrete shall be placed within [90] [_____] minutes after it has been mixed. It shall be placed on clean, damp surfaces free from water, ice, frost, mud, debris, or objectionable coatings. Concrete shall be consolidated with the aid of mechanical vibrating equipment supplemented by handspading and tamping. Vibrating equipment shall be of the internal type.

3.6.2 Lifts in Concrete

Concrete shall be deposited in horizontal layers not to exceed [600] [_____] millimeter [24] [_____] inches in thickness. Placement shall be carried on at a rate that will prevent the formation of cold joints. Slabs shall be placed in one lift.

3.6.3 Hot-Weather Placement

When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI/MCP 205 and as specified.

- a. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 degrees F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using Liquid nitrogen to cool concrete is Contractor's option.
- b. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
- c. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
- d. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Contracting Officer.

3.7 FINISHING

Defective concrete, voids left by the removal of tie rods, and ridges and local bulging on concrete surfaces permanently exposed to view or exposed to water on the finished structure shall be repaired immediately after the removal of forms. Voids left by the removal of the tie rods shall be

reamed and completely filled with dry-patching mortar. Defective concrete shall be repaired by cutting out the unsatisfactory material and placing new concrete secured with keys, dovetails, or anchors. Excessive rubbing of formed surfaces will not be permitted. Unformed surfaces of concrete exposed in the completed work shall have a wood float finish without additional mortar and shall be true to indicated elevations. Other surfaces shall be brought to specified elevations and left true and regular.

Floor flatness and floor levelness shall be checked using the F-Number System in accordance with [ASTM E 1155M](#) [ASTM E 1155](#). Slab sections measuring at or above both of the specified minimum local F-numbers shall be accepted for tolerance compliance as constructed. Sections of floor slabs-on-grade measuring below either (or both) of the specified minimum local F-numbers shall be removed and replaced or ground. Sections of elevated slabs measuring below either (or both) of the specified minimum local F-numbers shall be retopped. No remedies for sub-minimum local F-number other than replacement of slabs-on-grade, and grinding or re-topping of elevated slabs will be permitted. For the purposes of this paragraph, a floor section shall be rectangular area bound by column or half-column lines or 100 square feet minimum floor area.

3.8 TROWEL FINISH

A trowel finish shall be applied to slab surfaces that are to be exposed to view or covered with resilient flooring, paint, or other finish coating systems.

Final troweling shall be started when a ringing sound is produced as trowel is moved over the surface. Surface shall be consolidated by hand troweling operation. Finished surfaces shall be free of trowel marks, uniform in texture and appearance. Surface defects of sufficient magnitude to show through floor covering shall be removed by grinding.

3.8.1 Flat Floor Finishes

NOTE: Floor flatness and floor levelness will affect the appearance and function of finishes applied to the concrete and in situations such as large or long expanses of glossy floor materials. Low tolerances for subsequent finish materials (thin set ceramic and porcelain tile and wood gymnasium floors, etc.) and equipment will dictate to the designer to specify higher than normal floor flatness requirements. Higher "F" are more stringent and tighter tolerances of F numbers stop at 100. The numbers provided in brackets are typical numbers, but A/E should research and select F numbers high enough to get desired results but not so high as to cause undue cost increases and construction issues. A FF20/FL15 is equivalent to 8 mm in 5.05 5/16 inches in 10 feet. This test method is not suitable for unshored decks. Fitted partitions need FL greater than or equal to 25.

[ACI/MCP 205](#) construct in accordance with one of the methods recommended in Table 7.15.3, "Typical Composite FF/FL Values for Various Construction Methods." [ACI 117](#) for tolerances tested by [ASTM E 1155M](#) [ASTM E 1155](#).

These requirements are based upon the latest FF/FL method.

Floor slabs shall conform to the following ACI F-number requirements unless noted otherwise:

NOTE: The F-numbers are given for purposes of illustration only.

a. Slab on Grade:

Specified Overall Values - FF30/FL23 minimum [FF____/FL____]
Minimum Local Values - FF17/FL15 minimum [FF____/FL____]

b. Level Suspended Slabs Shored Until After Testing:

Specified Overall Values - FF25/FL20 minimum [FF____/FL____]
Minimum Local Values - FF17/FL15 minimum [FF____/FL____]

c. Unlevel Shored Suspended Slabs and Unshored Suspended Slabs:

Specified Overall Values - FF25 [FF____]
Minimum Local Values - FL17 [FL____]

Floor slabs subject to vehicular traffic or receiving thin-set flooring shall conform to the following ACI F-number requirements:

a. Slab on Grade:

Specified Overall Values - FF35/FL25 minimum [FF____/FL____]
Minimum Local Values - FF25/FL17 minimum [FF____/FL____]

b. Level Suspended Slabs Shored Until After Testing:

Specified Overall Values - FF30/FL20 minimum [FF____/FL____]
Minimum Local Values - FF25/FL15 minimum [FF____/FL____]

c. Unlevel Shored Suspended Slabs and Unshored Suspended Slabs:

Specified Overall Values - FF30 [FF____]
Minimum Local Values - FL25 [FL____]

3.8.1.1 [Measurement of Floor Tolerances](#)

Test floor slabs within 24 hours of the final troweling. Provide tests to Contracting Officer within 12 hours after collecting data. Floor flatness inspector shall provide a tolerance report which shall include:

- a. Name of Project
- b. Name of Contractor
- c. Date of Data Collection
- d. Date of Tolerance Report
- e. A Key Plan Showing Location of Data Collected

f. Results Required by ASTM E 1155M ASTM E 1155

3.9 CHEMICAL-HARDENER TREATMENT

NOTE: Slab surfaces requiring a chemical hardener must be indicated. Such treatment is suitable for surfaces of concrete floors in equipment rooms and on other floor surfaces that are subject to light foot traffic only and will not be covered with resilient flooring, paint, or other finish coating.

Liquid-Chemical Floor Hardener shall be applied where indicated after curing and drying concrete surface. Liquid hardener shall be diluted with water and applied in three coats. First coat shall be one-third strength, second coat one-half strength, and third coat two-thirds strength. Each coat shall be applied evenly and allowed to dry 24 hours between coats.

Proprietary chemical hardeners shall be applied in accordance with manufacturer's printed directions.

3.10 CURING AND PROTECTION

Concrete shall be cured in accordance with ACI/MCP 205.

Curing shall be accomplished by moist curing, by moisture-retaining cover curing, by membrane curing, or by combinations thereof.

Moist curing shall be accomplished by keeping surface of concrete wet or by covering with absorptive cover saturated with water and kept wet.

Moisture-retaining cover curing shall be accomplished by covering concrete surfaces with moisture-retaining cover for curing concrete.

Membrane curing shall be accomplished by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared.

3.11 FIELD TESTING

Concrete shall be sampled and tested for quality control during placement. Quality control testing shall be provided by the Contractor.

Sampling of fresh concrete for testing shall be in accordance with ASTM C 172.

Concrete shall be tested for compressive strength at 7 and 28 days for each design mix. Concrete test specimens shall conform to ASTM C 31/C 31M and compressive strength testing shall be in accordance with ASTM C 39/C 39M.

Slump shall be tested at the [plant] [site of discharge] for each design mix in accordance with ASTM C 143/C 143M.

Air content for air-entrained concrete shall be tested in accordance with ASTM C 231 except that concrete using lightweight or extremely porous aggregates shall be tested in accordance with ASTM C 173/C 173M.

Temperature of concrete at time of placement shall be determined in accordance with ASTM C 1064/C 1064M.

-- End of Section --