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USACE / NAVFAC / AFCEC / NASA **UFGS-03 37 23 (November 2009)**

Preparing Activity: USACE **Superseding**
UFGS-03 37 23 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 03 37 23

ROLLER-COMPACTED CONCRETE FOR MASS CONCRETE CONSTRUCTION

11/09

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SECTION 03 37 23

ROLLER-COMPACTED CONCRETE FOR MASS CONCRETE CONSTRUCTION

11/09

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NOTE: This guide specification covers the requirements for furnishing, hauling, placing, and roller-compacting concrete for mass concrete construction. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

PART 1 GENERAL

1.1 UNIT PRICES

****

NOTE: If Section 01 20 00 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 20 00.

See appropriate Design Memorandum (DM) for concrete items that are to be measured by the neat line, batch or lump sum.

****

1.1.1 Roller-Compacted Concrete (RCC) in [_____]

****

NOTE: Repeat this bid item and its respective subparagraphs for each bid item of concrete, renumbering the bid items appropriately.

See the Design Memorandum on the use of the optional item on air entrainment.

If bedding concrete is to be paid for as a separate bid item, delete the optional words, "Bedding concrete and", below.

****

1.1.1.1 Payment

Payment will be made for costs associated with completing the concrete work for roller-compacted concrete placed in the [_____], including all aggregate [, air-entraining admixture,] and the use of all equipment and tools to complete the concrete work. However, these costs will not include the cost of the cement, pozzolan, [water-reducing admixture,] and embedded parts that are specified to be paid for separately. [Bedding concrete and] bedding mortar [is] [are] incidental to the RCC and will be paid for as part of the RCC within the neat lines. [Joint materials, waterstops, sealants, and bond breakers are incidental to the concrete and will be paid for as part of the RCC.] No payment will be made for concrete, as such, that is placed in structures of which payment is made as a lump sum.

1.1.1.2 Measurement

Roller-compacted concrete will be measured for payment on the basis of the actual volume of RCC within the pay lines of the structures as indicated on the drawings. Measurement of RCC placed against the sides of any excavation without the use of intervening forms shall be made only within the pay lines of the structure. No deductions shall be made for rounded or beveled edges, space occupied by metal work, electrical conduits or reinforcing steel, nor for voids or embedded items that are either less than 0.14 cubic meter 5 cubic feet in volume or 0.09 square meter 1 square foot in cross section.

1.1.1.3 Unit of Measure

Unit of measure: cubic meter yard.

[1.1.2 Dental Concrete

1.1.2.1 Payment

Payment will be made for costs associated with placing dental concrete.

1.1.2.2 Measurement

Dental concrete will be measured for payment based upon the actual volume of dental concrete placed. The dental concrete volume in cubic meters yards will be computed from the mass weight of the material batched at the batch plant using the theoretical mass per meter weight per yard as

determined from the design mixture. Any concrete which is wasted or placed in violation of the specifications will not be measured for payment.

1.1.2.3 Unit of Measure

Unit of measure: cubic meter yard.

][1.1.3 Bedding Concrete

****
NOTE: If bedding concrete is to be paid for as a separate bid item, delete the optional wording "Bedding concrete and" in Bid Item "(1) Roller-Compacted Concrete (RCC) in [_____]", above.
****

1.1.3.1 Payment

Payment will be made for costs associated with placing bedding concrete.

1.1.3.2 Measurement

Bedding concrete will be measurement for payment based upon the actual volume of bedding concrete placed. The bedding concrete volume in cubic meters yards will be computed from the mass weight of the material batched at the batch plant using the theoretical mass/meter weight/yard as determined from the design mixture. Any concrete which is wasted or placed in violation of the specifications will not be measured for payment.

1.1.3.3 Unit of Measure

Unit of measure: cubic meter yard.

]1.1.4 Portland Cement

1.1.4.1 Payment

Payment will be made for costs associated with portland cement, including the cost of required unloading, hauling, handling, and storage at the site, of all portland cement used in the work for all of the concrete bid items.

1.1.4.2 Measurement

Portland cement will be measured for payment based upon the number of tons (metric) (2,000 pounds) of portland cement used, excluding amount specifically excepted, wasted, or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the approved batch mass in kg/cubic meter weight in pounds per cubic yard of portland cement in each type of concrete used by the number of cubic meters yards of concrete types placed within the pay lines of the structure, as determined in accordance with the concrete bid items, and dividing by 1000 2,000.

1.1.4.3 Unit of Measure

Unit of measure: tons (metric) (2,000 pounds).

1.1.5 Pozzolan

1.1.5.1 Payment

Payment will be made for costs associated with pozzolan, including the cost of required unloading, hauling, handling, and storage at the site, of all pozzolan used in the concrete bid items.

1.1.5.2 Measurement

Pozzolan will be measured for payment based upon the number of cubic meters feet solid volume of pozzolan used unless specifically excepted, wasted, or used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the approved batch mass in kg/cubic meter weight in pounds per cubic yard of pozzolan in each type of concrete used by the number of cubic meters yards of concrete of the types placed within the pay lines of the structure, as determined in accordance with the concrete bid items, and dividing by the product of the average specific gravity of the pozzolan multiplied by 1000 kg/cubic meter 62.4 pcf. The average specific gravity shall be the average of the test results for all material accepted during the period covered by the payment.

1.1.5.3 Unit of Measure

Unit of measure: cubic meter foot solid volume.

1.1.6 Water-Reducing Admixture (WRA)

1.1.6.1 Payment

[Payment will be made for costs associated with water-reducing admixture (WRA) at the applicable contract unit price per cubic yard of concrete containing water-reducing admixture.][Payment will be made for costs associated with water-reducing admixture (WRA) at the applicable contract unit cost of concrete containing water-reducing admixture for:

a. "Bid Item [_____]a., first [_____] cubic meters yards".

b. "Bid Item [_____]b., all over [_____] cubic meters yards".]

1.1.6.2 Measurement

Water-reducing admixture (WRA) will be measured for payment based upon the actual volume of roller-compacted concrete containing the admixture and within the pay lines of the structures, as determined in accordance with the concrete bid items.

1.1.6.3 Unit of Measure

Unit of measure: cubic meter yard.

1.1.7 RCC Test Section

****

NOTE: The Test Section may be paid for as a lump sum pay item provided test section requirement are clearly specified.

****

1.1.7.1 Payment

Payment will be made for costs associated with completing the roller-compacted test section, including equipment and tools needed to complete the test section.

1.1.7.2 Measurement

Roller-compacted concrete test section will be measurement for payment based upon the actual number of test sections taken.

1.1.7.3 Unit of Measure

Unit of measure: each.

1.2 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 Reference Identifier (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.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	(2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 347R	(2014; Errata 1 2017) Guide to Formwork for Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2019a) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2018) Standard Specification for Concrete

	Aggregates
ASTM C39/C39M	(2020) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C40/C40M	(2020) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C87/C87M	(2017) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94/C94M	(2020) Standard Specification for Ready-Mixed Concrete
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2014) Standard Test Method for Lightweight Particles in Aggregate
ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2017a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142/C142M	(2017) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2020) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2017a) Standard Test Method for Air

	Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C441/C441M	(2017) Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494/C494M	(2019) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2016) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C618	(2019) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C989/C989M	(2018a) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1040/C1040M	(2016) Standard Test Methods for In-Place Density of Unhardened and Hardened Concrete, Including Roller Compacted Concrete, by Nuclear Methods
ASTM C1064/C1064M	(2017) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000; R 2006) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 53	(2001) Test Method for Consistency of No-Slump Concrete Using the Modified Vebe Apparatus
COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1997) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
EM 385-1-1	(2014) Safety and Health Requirements Manual

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Batch Plant; G[, [_____]].
Compaction Equipment; G[, [_____]].
Aggregate Production Schedule; G[, [_____]]
Regular Lift-Joint Treatment; G[, [_____]]
Curing and Protection; G[, [_____]].
Cold-Weather Protection; G[, [_____]]
Hot-Weather Protection; G[, [_____]]
Contraction Joints
Gallery
Vertical Facings for RCC Construction; G[, [_____]]

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Government Testing

****
NOTE: Contact the division laboratory for guidance in filling in the blanks.
****

The aggregate sources listed in paragraph COMMERCIAL CONCRETE AGGREGATE SOURCES in PART 2, have been tested and, at the time testing was performed, were capable of producing materials of the quality required for this project, provided suitable processing is performed. Samples from any source selected, whether listed or not listed, consisting of not less than [_____] kg pounds of each size coarse aggregate and [_____] kg pounds of fine aggregate, and taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100, shall be delivered to [_____] within 15 days after Notice to Proceed. Sampling, shipment, and testing of samples shall be at the Contractor's expense. [_____] days will be required to complete evaluation of the aggregates. All quality assurance testing will be performed by the Government in accordance with the applicable COE CRD-C or ASTM test methods. The material from the proposed source shall meet the quality requirements of this paragraph to be used for this project. The Government test data and other information on aggregate quality of those sources listed in PART 2 are included in the Design Memorandum and are available for review in the district office. Quality assurance testing of aggregates by the Government does not relieve the Contractor of quality control requirements.

1.4.2 Cementitious Materials and Admixtures

[At least [_____] days in advance of submitting samples for mixture proportioning studies,] [Not later than [_____] days after Notice to Proceed] notify the Contracting Officer of the source, brand name, type, and quantity of all materials (other than aggregates) to be used in the manufacture and curing of the concrete. Assist the Contracting Officer in obtaining samples of each material. Sampling and testing, as determined appropriate, will be performed by and at the expense of the Government. If cement or fly ash are to be obtained from more than one source, the notification shall state the estimated amount of cement or fly ash to be obtained from each source and the proposed schedule of shipments. When pozzolan other than fly ash is used, it shall be from one source.

1.4.3 Government Testing During Construction

The Government will sample and test cementitious materials, admixtures, aggregates, and concrete during construction as considered appropriate to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with COE CRD-C 100. Slump and air content of conventional concrete will be determined in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively, except the point of sampling will be as specified in paragraph TESTS AND INSPECTIONS in PART 3. Compression test specimens of conventional concrete will be made and laboratory cured in accordance with ASTM C31/C31M and will be tested in accordance with ASTM C39/C39M. Consistency of the RCC will be determined by the Government using the modified Vebe apparatus in accordance with paragraph CONSISTENCY OF RCC above. Compression test specimens of RCC will be made

and tested by the Government. Density of the compacted RCC will be checked by the Government as considered appropriate.

1.4.3.1 Aggregates Testing

Testing performed by the Government will not relieve the Contractor of its responsibility for testing under paragraph TESTS AND INSPECTIONS in PART 3. During construction, aggregates will be sampled for acceptance testing as delivered to the mixer to determine compliance with specification provisions. Provide necessary facilities and labor for the ready procurement of representative samples under Government supervision. The Government will test such samples at its expense using the specified COE CRD-C and ASTM methods.

1.4.3.2 Cementitious Materials

Cement or pozzolan will be sampled at the mill, shipping point, or site of the work by the Government. A list of prequalified cement sources and prequalified pozzolan sources is available from the Commander and Director, U.S. Army Engineer Waterways Experiment Station (CEWES-SC-MP), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199. If tests prove that a material which has been delivered is unsatisfactory, it shall be promptly removed from the site of the work. Cementitious materials that have not been used within 6 months after being tested will be retested by the Government at the expense of the Contractor when directed by the Contracting Officer.

1.4.3.3 Prequalified Cement Sources

Deliver and use cement directly from a mill of a producer designated as a prequalified source for the type of cement being used. Samples of cement for quality-assurance testing will be taken at the project site or cement-producing plant by the Contracting Officer for testing at the expense of the Government. A copy of the mill tests from the cement manufacturer shall be furnished for each lot.

1.4.3.4 Prequalified Pozzolan Sources

Deliver and use pozzolan directly from a producer designated as a prequalified source. Samples of pozzolan for check testing will be taken at the project site by the Contracting Officer for testing at the expense of the Government. A copy of the test results from the pozzolan manufacturer shall be furnished for each lot.

1.4.3.5 Nonprequalified Cement Sources

****

NOTE: The Contractor's expense rate for excess testing of cement and Pozzolan by the Government can be obtained from the Structures Laboratory, U.S. Army Engineer Waterways Experiment Station (CEWES-SC-MP), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

****

Cement, if not from a prequalified source, will be sampled and tested by or under the supervision of the Government and at its expense. No cement shall be used until notice has been given by the Contracting Officer that test results are satisfactory. In the event of failure, the cement may be

resampled and tested at the request of the Contractor and at the Contractor's expense. The fill gate or gates of the sampled bin will be sealed and kept sealed until shipment from the bin has been completed. Sealing of the fill gate or gates and of conveyances used in shipment will be done by or under the supervision of the Government. Conveyances will not be accepted at the site of the work unless received with all seals intact. If tested cement is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing cement excess to project requirements will also be at the Contractor's expense and will be deducted from payments due the Contractor at a rate of [_____] dollars per test.

1.4.3.6 Nonprequalified Pozzolan Sources

Pozzolan, if not from a prequalified source, will be sampled at the source or at the site of the work and will be stored in sealed bins pending completion of acceptance tests. Pozzolan may be resampled at the site when determined necessary. All sampling and testing will be performed by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical, chemical, and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed. Release for shipment and approval for use on this basis will be contingent on continuing compliance with the other requirements of the specifications. If test results of a bin fail, the contents may be resampled and tested at the Contractor's expense. The Government will supervise or perform the unsealing and resealing of bins and shipping conveyances. If tested pozzolan is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing excess pozzolan in excess of project requirements will be at the Contractor's expense at a rate of [_____] dollars per test. The amount will be deducted from payment to the Contractor.

1.4.3.7 Admixtures

Provide satisfactory facilities for ready procurement of adequate test samples. All sampling and testing of an admixture will be by and at the expense of the Government. Tests will be conducted on the same materials which will be shipped to the project.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Cementitious Materials

1.5.1.1 Transportation

When bulk cement or pozzolan is not unloaded from primary carriers directly into weather-tight hoppers at the batching plant, transportation from the railhead, mill, or intermediate storage to the batching plant shall be accomplished in adequately designed weather-tight trucks, conveyors, or other means that will protect the material from exposure to moisture.

1.5.1.2 Storage

Furnish cementitious materials in bulk. Immediately upon receipt at the site of the work, all cementitious materials shall be stored in a dry, weather-tight, and properly ventilated structure. All storage facilities shall permit easy access for inspection and identification. Sufficient

materials shall be in storage for at least two operating days of continuous placement. In order that cement may not become unduly aged after delivery, use any cement that has been stored at the site for 60 days or more before using cement of lesser age.

1.5.2 Aggregate Storage

****
NOTE: Consult the materials engineer to select the appropriate optional phrase and to fill in the blank.
****

Fine aggregate and each size of coarse aggregate shall be stored in separate size groups adjacent to the batch plant and in such a manner as to prevent the intermingling of size groups or the inclusion of foreign materials in the aggregate. Sufficient fine and coarse aggregate shall be maintained at the site for at least [30] [_____] operating days of continuous placement.

1.5.3 Chemical Admixtures

Any admixture that has been in storage at the project site for longer than recommended by the manufacturer or that has been subjected to freezing shall not be used in the work and shall be removed from the site.

1.6 ENVIRONMENTAL REQUIREMENTS

****
NOTE: Make sure the climatological data is included if that optional sentence is included.
****

If unusual adverse weather, such as heavy rain, severe cold, high winds, heavy snow, etc., occurs or is forecast to occur during placement, the placement operation shall be suspended until conditions improve. [A sample of available climatological data for this project based on historical information is contained herein for general information only. However, it is the responsibility of the Contractor to maintain the construction schedule at no additional cost to the Government.]

1.6.1 Cold-Weather Placement

In Cold-weather placement the RCC shall not be placed when the ambient air temperature drops below 0 degrees C 32 degrees F. If the ambient air temperature does drop below 0 degrees C 32 degrees F, the surface of any recently placed (within the previous 72 hours) and exposed horizontal RCC surface shall not remain exposed for more than 4 hours. Surfaces that will be exposed for longer times shall be protected as specified in paragraph COLD-WEATHER PROTECTION in PART 3 as a measure to maintain RCC temperatures above 0 degrees C 32 degrees F until after the ambient air temperature rises to above 0 degrees C 32 degrees F and is expected to remain above 0 degrees C 32 degrees F until the end of the curing and protection period, or until covered by another lift.

1.6.2 Placing During Rain

RCC shall not be placed during rainfall of 2.5 mm/hr 0.1 inch/hr or more. During periods of lesser rainfall, placement of RCC may continue if, in the opinion of the Contracting Officer, no damage to the RCC is

occurring. Work shall commence only after excess free surface water and contaminated paste or RCC have been removed and the surface has gained sufficient strength (no less than 4 hours after the RCC placement was suspended) to prevent rutting, pumping, intermixing of rainwater with the RCC, or other damage to the RCC. When the RCC surface has been contaminated or damaged in any manner, the RCC surface shall be washed to break up and remove laitance and/or mud-like coatings from the surface. Any undercut coarse aggregate shall be removed. All waste shall be removed and disposed of in an approved manner.

1.6.3 Hot-Weather Placement

****

NOTE: Refer to the concrete materials DM for use of the optional sentences and the correct placing temperature.

****

In hot-weather placement the temperature of the RCC shall be controlled so that it does not exceed [25] [_____] degrees C [75.0] [_____] degrees F when placed. Placement shall be suspended as soon as the RCC temperature exceeds [25] [_____] degrees C [75] [_____] degrees F. Measures that can be taken to prevent temperatures exceeding [25] [_____] degrees C [75] [_____] degrees F include, but are not limited to, chilling mixing water, sprinkling aggregate stockpiles, use of a canopy to shade the RCC placement areas, placing during nighttime and early morning hours, or restricting placements to cloudy days. Use of any of these systems shall not be reason for extension of completion dates specified in these specifications. [In addition, to prevent potential damage to the RCC due to hot-weather related placement conditions, all RCC operation shall be suspended between [_____] [June 15th] and [October 31st] [_____]].

PART 2 PRODUCTS

2.1 RCC SYSTEM

****

NOTE: Contact the materials engineer or the concrete materials DM for information on filling in the blanks.

****

2.1.1 General Requirements

Perform all work in accordance with EM 385-1-1. Provide RCC composed of cementitious materials, water, fine and coarse aggregates, and possibly admixtures. The cementitious material shall be portland cement, or portland cement in combination with pozzolan. An admixture, when approved or directed, will be a water-reducing/retarding admixture. Air-entraining admixture will be used in the bedding concrete and other conventional concrete.

2.1.2 Mixture Proportions and Studies

RCC mixtures and all conventional concrete mixtures that interface with the RCC (such as facing concrete and bedding mixtures) will be proportioned by the Contracting Officer [except that slipformed facing concrete mixture will be proportioned by the Contractor]. There will be one primary RCC mixture used for the mass of the dam [, _____,] [and

_____]. The primary mixture will contain approximately [_____] to [_____] kg pounds water, [_____] kg pounds portland cement and [_____] kg pounds pozzolan per cubic meter yard. [Secondary RCC mixtures requiring higher portland cement and pozzolan contents (approximately [_____] to [_____] kg pounds per cubic meter yard) will be used for [_____] [, _____,] [and _____].] There also will be a "bedding mortar" and "bedding concrete." The bedding mortar is a broomable mixture containing approximately 280 to 355 kg 475 to 600 pounds of portland cement and 135 to 180 kg 225 to 300 pounds pozzolan per cubic meter yard. The bedding mortar will have 9.5 mm 3/8-inch nominal maximum size aggregate and a slump, when placed, of 175 to 225 mm 7 to 9 inches. The bedding concrete, 75 to 100 mm 3 to 4 inch slump conventional concrete, shall contain 19.0 mm 3/4-inch nominal maximum size aggregate and approximately [_____] kg pounds of portland cement and pozzolan per cubic meter yard. The air content of the bedding concrete as delivered to the placement site shall be between 4.5 and 7.5 percent. [Preliminary mixture proportioning studies are available for review in the District office.] Concrete mixtures used for [the upstream face] [, and _____,] and other conventional concrete mixtures shall contain from [_____] to [_____] kg pounds of cementitious materials and the slump shall be between 25 and 100 mm 1 and 4 inches.

2.1.3 Proportioning Responsibility

The proportions of all materials entering the RCC and the conventional concrete will be furnished. The proportions will be changed as necessary by the Government. Adjustments will be made to the batch weights, including cement, pozzolan, and water, to maintain the necessary consistency to prevent segregation within the RCC and allow full compaction as determined. Frequent changes to the batch weights shall be considered usual and can be expected to occur frequently during the course of each day's placement depending on such variables as humidity, wind velocity, temperature, and cloud cover. Such changes will be as directed. The Contractor will be responsible for adjusting the added water to compensate for changes in aggregate moisture content and to adjust the amount of air-entraining admixture (if used) to keep the percent of air within the specified range.

2.1.4 Nominal Maximum Size of Aggregate

The nominal maximum size of coarse aggregate to be used in the various parts of the work shall be in accordance with following:

FEATURES	NOMINAL MAXIMUM SIZE AGGREGATE
[RCC used in the main concrete gravity dam]	75 mm3 inches
[RCC used in construction of the [_____]]	
[Conventional concrete for the upstream face]	
[Conventional concrete for the [_____]]	
[RCC used in the [_____]]	37.5 mm1-1/2 inch
[RCC used in the [_____]]	

FEATURES	NOMINAL MAXIMUM SIZE AGGREGATE
[Conventional concrete for [_____]]	
[Conventional concrete bedding mixture]	19.0 mm3/4 inch
[Bedding mortar]	4.75 mmNo. 4
Note: The nominal maximum size aggregate may be changed for applications requiring a special quality of concrete as directed.	

2.1.5 Consistency of RCC

The Contracting Officer will determine at the placement site on a continuing basis the proper consistency necessary for adequate hauling, spreading, and compacting and will direct all necessary changes to achieve the proper RCC consistency. Changes will be directed based on visual examination of the RCC during the spreading and compaction process and on the Vebe time when it varies outside the range considered ideal for compaction, as determined by the Government using the modified Vebe apparatus, in accordance with COE CRD-C 53.

2.1.6 Materials for Mixture-Proportioning Studies

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NOTE: Contact the Division Lab to fill in the blanks.

****

At least [_____] days in advance of the time when placing of concrete is expected to begin, samples of representative materials proposed for this project and meeting all the requirements of this specification shall be delivered to [_____] by the Contractor at its expense. Samples of aggregates shall be taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100, accompanied by test reports indicating conformance with grading and quality requirements hereinafter specified. Samples of materials other than aggregates shall be representative of those proposed for the project and shall be submitted accompanied by manufacturer's test reports indicating compliance with applicable specified requirements. Quantities of materials required shall be as follows:

MATERIAL	QUANTITY
75 mm 3 inches nominal maximum size coarse aggregate	[_____] kgpounds
37.5 mm 1-1/2 inch nominal maximum size coarse aggregate	[_____] kgpounds
19 mm 3/4 inch nominal maximum size coarse aggregate	[_____] kgpounds

MATERIAL	QUANTITY
Fine aggregate	[_____] kgpounds
Cement	[_____] kgpounds
Pozzolans	[_____] cu meters feet
Admixtures (each)	[_____] L gallons

Mixture-proportioning studies will be made by the Government at its expense.

2.2 MATERIALS

2.2.1 Cementitious Materials

****

NOTE: See the appropriate concrete aggregates DM or thermal study to select the proper requirements for cementitious materials options.

****

2.2.1.1 Portland Cement

Portland cement shall conform to ASTM C150/C150M, Type [_____], [low alkali when it is to be used with aggregates listed to require it in the paragraph COMMERCIAL CONCRETE AGGREGATE SOURCES below or when directed if a nonlisted source is permitted.] [the heat of hydration requirement at 7 days shall be no greater than [_____] calories per gram] [including false-set requirement]. [In lieu of low-alkali cement, the Contractor may use a combination of portland cement that does not meet the low-alkali requirement with a suitable pozzolan or ground granulated blast-furnace slag (GGBFS) provided the following requirement is met. The expansion of the proposed combination shall be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C150/C150M when tested in conformance with ASTM C441/C441M. These two tests shall be performed concurrently at an independent certified laboratory at the Contractor's expense. The Government reserves the right to confirm the test results and to adjust the percentage of pozzolan or GGBFS in the combination to suit other requirements at no additional cost to the Government.] Portland cement shall be furnished in bulk.

2.2.1.2 Pozzolan

Pozzolan shall conform to ASTM C618, Class C or F, including low alkali [multiple factor,] [drying shrinkage,] [uniformity,][and][moderate] [severe] sulfate resistance requirements of Table 2A. Uniformity Requirements (for air content) shall apply to all fly ash. [Table 1A, Supplementary Optional Chemical Requirement for Maximum Alkalies, shall apply when it is to be used with aggregates listed to require low-alkali cement]. Pozzolan shall be furnished in bulk.

2.2.1.3 Ground Granulated Blast-Furnace (GGBF) Slag

Ground Granulated Blast-Furnace Slag shall conform to ASTM C989/C989M, Grade 100 or Grade 120.

2.2.1.4 Temperature of Cementitious Materials

The temperature of the cementitious materials as delivered to the site shall not exceed 65 degrees C 150 degrees F.

2.2.2 Admixtures

All chemical admixtures furnished as liquids shall be in a solution of suitable viscosity and dilution for field use as determined by the Contracting Officer.

2.2.2.1 [Water-Reducing Admixture (WRA)

A WRA shall meet the requirements of ASTM C494/C494M, Type D, except that the 6-month and 1-year compressive strength tests are waived. The admixture may be added to the concrete mixture only when its use is approved or directed and after mixture proportioning studies.]

2.2.2.2 Air-Entraining Admixture

Air-entraining admixture shall conform to ASTM C260/C260M.

2.2.3 Water

Water for washing aggregates and for mixing and curing concrete shall be free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances and shall comply with COE CRD-C 400.

2.2.4 Aggregates

****

NOTE: See the concrete materials DM to select the aggregate composition options.

This note may be disregarded for regions where Alkali-Silica Reactivity (ASR) is not a concern. Some aggregate sources may exhibit an ASR potential. ASR is a potentially deleterious reaction between alkalis present in concrete and some siliceous aggregates, reference EM 1110-2-2000 paragraph 2-3b(6) and appendix D. Use of cementitious materials meeting the low alkali requirement may be effective in some applications, and insufficient in others. In regions where imposing the low alkali requirement has not been effective in controlling ASR, additional effort for evaluation and mitigation may be required. In which case, the alternate procedures to proportion cementitious materials to meet the low alkali requirement in paragraph 2.1.1.1 Portland Cement should not be used with the following requirements. Where ASR is known or suspected to pose a concern for concrete durability, it is recommended that aggregates proposed for use in concrete be evaluated

to determine ASR potential and an effective mitigation. EM 1110-2-2000, provides recommendations for evaluating and mitigating ASR in concrete mixtures. Aggregate evaluations may not be practical for projects requiring small quantities of concrete (less than 200 cubic meters 250 cubic yards).

Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, paragraph 2.3.1.2 Alkali-Silica Reactivity, provides a specification method for the Contractor to evaluate and mitigate ASR in concrete mixtures. The expansion limits specified in Section 32 13 14.13 are requirements for pavements and exterior slab construction. For structural concrete applications the measured expansion shall be less than 0.10 percent. It may not be economical or practical to specify different test limit requirements for use on the same project. In which case the lower limit required by the application should be used.

The designer may use the specification method in Section 32 13 14.13 by incorporating the relevant paragraphs into this specification, or may use the following requirements (retain either the 0.10 or the 0.08 percent expansion limits as appropriate).included in the set of brackets highlighted thus "[ ]".

****

2.2.4.1 Composition

[Fine aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sands. Coarse aggregate shall consist of [gravel], [crushed gravel], [crushed stone], [air-cooled blast-furnace slag], or a combination thereof.] "[Fine and coarse aggregates proposed for use in concrete shall be tested and evaluated for alkali-aggregate reactivity in accordance with ASTM C1260. The fine and coarse aggregates shall be evaluated separately and in combination, which matches the Contractor's proposed mix design proportioning. All results of the separate and combination testing shall have a measured expansion less than 0.10 (0.08) percent at 16 days after casting. Should the test data indicate an expansion of 0.10 (0.08) percent or greater, the aggregate(s) shall be rejected or additional testing using ASTM C1260 and ASTM C1567 shall be performed. The additional testing using ASTM C1260 and ASTM C1567 shall be performed using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. GGBF slag shall be used in the range of 40 to 50 percent of the total cementitious material by mass. Class F fly ash shall be used in the range of 25 to 40 percent of the total cementitious material by mass.]"

2.2.4.2 Quality

****

NOTE: The tests selected should be those which are applicable to the concrete to be used in the project. These tests may include those listed below in addition to others not listed. See EM

1110-2-2000 for schedule of tests.

Only a limited number of laboratories are now running ASTM C123/C123M due to the toxic chemicals required. Recommend that ASTM C295/C295M/C295M be specified.

A list of properties and test values are unique to each project and should be taken from the concrete materials DM. Delete the quality tests not required in the DM.

The petrographic examination shall be used to identify deleterious substances in aggregates. Deleterious substances shall be listed individually with respective limits.

****

Aggregates delivered to the mixer shall meet the following requirements:

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Specific Gravity	[_____]	[_____]	ASTM C127 ASTM C128
Absorption	[_____]	[_____]	ASTM C127 ASTM C128
Flat and Elongate	[_____]	25 percent max.	ASTM D4791
Durability Factor using Procedure A	[_____]	[_____]	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	[_____]	[_____]	ASTM C142/C142M
Material Finer than 75 µm No. 200 Sieve	[_____]	[_____]	ASTM C117
Liquid Limit and Plastic Limit on material passing the 75 µm No. 200 sieve size	LL 30 max., PI 10 max.	[_____]	ASTM D4318
Organic Impurities	Not Darker than No. 3, Not less than 95 percent	[_____]	ASTM C40/C40M ASTM C87/C87M

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
L.A. Abrasion	[_____]	[_____]	ASTM C131/C131M ASTM C535
Soft Particles	[_____]	[_____]	COE CRD-C 130
Petrographic Examination	List unwanted deleterious materials and their limits	[_____]	ASTM C295/C295M
Percent coarse aggregate with 2 or more fractured faces	[_____]	20 percent min.	[_____]
Chert, less than 2.40 specific gravity	[_____]	[_____]	ASTM C123/C123M ASTM C295/C295M
[Coal and Lignite, less than 2.00 specific gravity]	[_____]	[_____]	ASTM C123/C123M or ASTM C295/C295M

2.2.4.3 Grading

****
NOTE: See DM for appropriate fine aggregate options.
****

a. Fine Aggregate - The grading of the fine aggregate as delivered to the mixer for the RCC shall be such that the individual percent retained on any sieve shall not vary more than 3 percent from the percent retained on that sieve in a fixed grading selected by the Contractor after the first 30 days of concrete placement. The minimum percent retained on each of the 2.36 mm No. 8 through 75 µm No. 200 sieve sizes shall be 5 percent. In additional to the grading limits, the fine aggregate, as delivered to the mixer, shall have a fineness modulus of not less than 2.10 nor more than 2.75. The grading of the fine aggregate shall also be controlled so that the fineness moduli for at least four of five consecutive test samples of the fine aggregate as delivered to the mixer shall not vary more than 0.10 from the fineness modulus of the fixed grading selected by the Contractor, and approved. The fineness modulus shall be determined in accordance with COE CRD-C 104. At the option of the Contractor, fine aggregate may be separated into two or more sizes or classifications, but the uniformity of the grading of the separate sizes shall be controlled so that they may be combined throughout the job in fixed proportions established during the first 30 days of RCC placement. The grading of the fine aggregate for the bedding concrete and all other conventional concrete shall conform to the requirements of [ASTM C33/C33M].

[Section 03 30 00 CAST-IN-PLACE CONCRETE] The fixed grading and the results of individual tests during the first 30 days shall fall within the following limits:

SIEVE DESIGNATION U.S. STANDARD SQUARE MESH	PERMISSIBLE LIMITS PERCENT BY MASS, PASSING
9.5 mm3/8 inch	100
4.75 mmNo. 4	95 - 100
2.36 mmNo. 8	75 - 95
1.18 mmNo. 16	55 - 80
600 µmNo. 30	35 - 60
300 µmNo. 50	24 - 40
150 µmNo. 100	12 - 28
75 µmNo. 200	*8 - 18
* The required fines smaller than the 75 µm No. 200 sieve size may substituted with Class F fly ash, at no additional cost to the Government.	

b. Coarse Aggregate - The grading of the coarse aggregate within the separate size groups shall conform to the following requirements as delivered to the mixer.

PERCENT BY MASS PASSING INDIVIDUAL SIEVES			
U.S. STANDARD SIEVE SIZE	4.75 mm No. 4 to 19.0 mm 3/4 inch	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inch
100 mm4 inch			100
75 mm3 inch			90 - 100
50 mm2 inch		100	20 - 55
37.5 mm1-1/2 inch		90 - 100	0 - 10
25 mm1 inch	100	20 - 45	0 - 5
19.0 mm3/4 inch	90 - 100	0 - 10	
9.5 mm3/8 inch	20 - 55	0 - 5	
4.75 mmNo. 4	0 - 10		

PERCENT BY MASS PASSING INDIVIDUAL SIEVES			
U.S. STANDARD SIEVE SIZE	4.75 mm No. 4 to 19.0 mm 3/4 inch	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inch
2.36 mmNo. 8	0 - 5		

2.2.4.4 Particle Shape

The shape of the particles of the fine aggregate and of the coarse aggregate shall be generally spherical or cubical. The quantity of flat and elongated particles at a length-to-width or width-to-thickness ratio greater than 3 in the separated size groups of coarse aggregate, as defined and determined by ASTM D4791, shall not exceed 25 percent in any size group.

2.2.4.5 Moisture Content

The fine aggregate shall not be placed in bins at the batch plant until it is in a stable state of moisture content. A stable moisture content shall be reached when the variation in the percent of total moisture tested in accordance with ASTM C566 and when sampled at the same location will not be more than 0.5 percent during one (1) hour of the two (2) hours prior to placing the material in the batch plant bins and the variation in moisture content when sampled at the same location shall not be more than 2.0 percent during the last 8-hour period that the aggregate remains in the stockpile. The coarse aggregate shall be delivered to the mixers with the least amount of free moisture and the least variation in free moisture practicable under the job conditions. Under no conditions shall the coarse aggregate be delivered to the mixer "dripping wet."

[2.2.4.6 Commercial Concrete Aggregate Sources

****
NOTE: The list of sources and required tests will be taken from the concrete materials DM.
****

Concrete aggregates may be furnished from any source capable of meeting the quality requirements stated in paragraph QUALITY above. The following sources were evaluated during the design phase of the project in [_____] and were found at that time capable of meeting the quality requirements when suitably processed. No guarantee is given or implied that any of the following listed sources are currently capable of producing aggregates that meet the required quality stated above. A DM containing the results of the Government investigation and test results is available for review in the [_____] District Office. Contact [_____] at [_____] to arrange for review of the DM. The test results and conclusions shall be considered valid only for the sample tested and shall not be taken as an indication of the quality of all material from a source nor for the amount of processing required.

a. List of Sources

****
NOTE: The concrete materials DM will list those

sources requiring low-alkali cement, which must be noted herein.
****

FINE AGGREGATE	COARSE AGGREGATE
F1: [_____] [1/]	C1: [_____] [1/]
F2: [_____]	C2: [_____]
F3: [_____]	C3: [_____]
[1/ Low-alkali cement must be used with these sources.]	

b. Selection of Source - After the award of the contract, designate in writing only one source or combination of sources from which to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or sources not listed above, he may designate only a single source or single combination of sources for aggregates. Regardless of the source selected, samples for quality-assurance testing shall be provided as required by PART 1, paragraphs PRECONSTRUCTION GOVERNMENT TESTING, and MIXTURE PROPORTIONS AND STUDIES both in PART 1. If a source for coarse or fine aggregate so designated by the Contractor does not meet the quality requirements stated in paragraph QUALITY above, the Contractor may not submit for approval any other unlisted sources but shall furnish the coarse or fine aggregate, as the case may be, from sources listed, provided it meets the requirements of the same paragraph, at no additional cost to the Government.

][2.2.4.7 Government-Furnished Concrete Aggregate Source

****
NOTE: The specification writer should ascertain that restoration of the pit or quarry site is specified under other sections.
****

a. Location - The deposits are [owned] [controlled] by the Government and are made available to the Contractor free of charge for production of aggregate required under this contract. Within the designated area, an adequate supply of material is available from which concrete aggregate meeting the requirement of these specifications can be produced with suitable processing. The Government guarantees that a sufficient amount of material of suitable quality for production of all of the concrete aggregate required is available within the deposit and that concrete aggregates of suitable quality can be produced with a properly designed and operated plant [without hand-picking or similar operations]. However, the amount of work involved or the amount of unsatisfactory materials required to be wasted to produce a sufficient quantity of suitable concrete aggregate shall be the responsibility of the Contractor, and the Government shall not be held liable for costs resulting from such work or waste. Produce the concrete aggregate from the following sites as shown in the drawings:

	QUARRY SITE	BAR	TERRACE	COORDINATES	DIST. and DIRECTION
G1					
G2					
G3					

b. Explorations - The deposits listed above have been explored by the Government to determine the character and extent of the materials available. The locations of the explorations are shown in the contract drawings. The logs of the exploratory holes are also shown in the drawings. Samples of materials secured are available for inspection at [_____]. The results of explorations are furnished for information only. These data are the result of limited explorations and tests conducted by and for the Government and are accurate to the extent of the scope of the investigations conducted. The Government will not be responsible for any deduction, interpretation, or conclusion drawn therefrom by the Contractor.

]2.3 PLANT AND EQUIPMENT

2.3.1 Concrete Plant

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NOTE: See the concrete materials DM or EM 1110-2-2000 for the plant size requirements.

See EM 1110-2-2000 and the concrete materials DM for selection of automatic or semiautomatic plant and for use of the rescreening and washing plant.

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The concrete plant, conveying, placing, compaction, and cleanup systems shall have a capacity of at least [_____] cubic meters yards per hour. The concrete plant shall be a batch or a continuous mixing plant.

2.3.2 Location

The concrete plant shall be located at the site of the work in the general area indicated in the drawings[, or shall be located offsite].

2.3.3 Bins and Silos

Separate bins, compartments, or silos shall be provided for each size or classification of aggregate and for each of the cementitious materials. The compartments shall be of ample size and so constructed that the various materials will be maintained separately under all working conditions.

2.3.4 Bulk Cement or Pozzolan

All compartments containing bulk cement or pozzolan shall be separated from each other by a free-draining air space. The cement and pozzolan bins shall be equipped with filters which allow air passage but preclude the venting of cement or pozzolan into the atmosphere. All filling ports shall be clearly marked with a permanent sign stating the contents.

2.3.5 Batch Plant

Submit details and data on the concrete plant [[_____] days prior to assembly] [not later than 30 days after Notice to Proceed] for review by the Contracting Officer. Final acceptance of any piece of plant is subject to satisfactory performance during operations. The batch plant should meet the following requirements.

2.3.5.1 Batchers

Aggregate shall be weighed in separate weigh batchers with individual scales [or may be batched cumulatively]. Bulk cement and other cementitious materials shall each be weighed on a separate scale in a separate weigh batcher. Water shall be measured by weight or by volume, but it shall not be weighed or measured cumulatively with another ingredient. Ice shall be measured separately by weight. Admixtures shall be batched separately and shall be batched by weight or by volume in accordance with the manufacturers recommendations.

2.3.5.2 Water Batcher

A suitable water-measuring and batching device shall be provided that will be capable of measuring and batching the mixing water within the specified tolerances for each batch. The mechanism for delivering water to the mixers shall be free from leakage when the valves are closed. The filling and discharge valves for the water batcher shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. When a water meter is used, a suitable strainer shall be provided ahead of the metering device.

2.3.5.3 Admixture Dispensers

A separate batcher or dispenser shall be provided for each admixture. Each plant shall be equipped with the necessary calibration devices that will permit convenient checking of the accuracy of the dispensed volume of the particular admixture. The batching or dispensing devices shall be capable of repetitively controlling the batching of the admixtures to the accuracy specified. Piping for liquid admixtures shall be free from leaks and properly valved to prevent backflow or siphoning. The dispensing system shall include a device or devices that shall detect and indicate the presence or absence of the admixture or provide a convenient means of visually observing the admixture in the process of being batched or discharged. Each system shall be capable of ready adjustment to permit varying the quantity of admixture to be batched. Each dispenser shall be interlocked with the batching and discharge operations so that each admixture is added separately to the batch in solution in a separate portion of the mixing water in a manner to ensure uniform distribution of the admixtures throughout the batch during the required mixing period. Storage and handling of admixtures shall be in accordance with the manufacturer's recommendations.

2.3.5.4 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. A moisture meter complying with the provisions of COE CRD-C 143 shall be provided for measurement of moisture in the fine aggregate. The sensing element shall be arranged so that the measurement is made near the batcher charging gate of the sand bin or in the sand

batcher.

2.3.5.5 Scales

Adequate facilities shall be provided for the accurate measurement and control of each of the materials entering each batch of concrete. The weighing equipment and controls shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be within 0.2 percent of the scale capacity. Provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device. Tests shall be made at the frequency required in paragraph TESTS AND INSPECTIONS in PART 3 and in the presence of a Government inspector. Each weighing unit shall include a visible indicator that shall indicate the scale load at all stages of the weighing operation and shall show the scale in balance at zero load. The weighing equipment shall be arranged so that the concrete plant operator can conveniently observe the indicators.

2.3.5.6 Operation and Accuracy

[The weighing operation of each material shall start automatically when actuated by a single starter switch and shall end automatically when the designated amount of each material has been reached. These requirements can be met by providing an automatic batching system as defined in the NRMCA CPMB 100.] [The weighing operation of each material shall begin automatically when actuated by one or more starter switches and shall end when the designated amount of each material has been reached. These requirements can be met by providing a semiautomatic or automatic batching system as defined by the NRMCA CPMB 100.] There shall be equipment to permit the selection of [_____] preset mixtures each by the movement of not more than two switches or other control devices. The weigh batchers shall be so constructed and arranged that the sequence and timing of batcher discharge gates can be controlled to produce a ribboning and mixing of the aggregates, water, admixtures, and cementitious materials as the materials pass through the charging hopper into the mixer. The plant shall include provisions to facilitate the inspection of all operations at all times. Delivery of materials from the batching equipment shall be within the following limits of accuracy:

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to +2
Water	±1
Aggregate smaller than 37.5 mm 1-1/2 inch size	±2
Aggregate larger than 37.5 mm 1-1/2 inch size	±3
Chemical admixtures	0 to +6
Note: When water or chemical admixtures are measured by volume, they shall meet the same tolerance percent as stated in the chart.	

2.3.5.7 Interlocks

Batchers and mixers shall be interlocked so that:

a. The charging device of each batcher cannot be actuated until all scales have returned to zero balance within plus or minus 0.2 percent of the scale capacity and each volumetric device has reset to start or has signaled empty.

b. The charging device of each batcher cannot be actuated if the discharge device is open.

c. The discharge device of each batcher cannot be actuated if the charging device is open.

d. The discharge device of each batcher cannot be actuated until the indicated material is within the allowable tolerances.

e. Admixtures are batched automatically and separately with the water.

f. The mixers cannot be discharged until the required mixing time has elapsed.

2.3.5.8 Recorder

An accurate recorder or recorders shall be provided and shall conform to the following detailed requirements:

a. The recorder shall produce a graphical or digital record on a single visible chart or tape of the weight or volume of each material in the batchers at the conclusion of the batching cycle. The record shall be produced prior to delivery of the materials to the mixer. After the batchers have been discharged, the recorder shall show the return to empty condition.

b. A graphical recording or digital printout unit shall be completely housed in a single cabinet that shall be capable of being locked.

c. The chart or tape shall be so marked that each batch may be permanently identified and so that variations in batch weights of each type of batch can be readily observed. The chart or tape shall be easily interpreted in increments not exceeding 0.5 percent of each batch weight.

d. The chart or tape shall show time of day at intervals of not more than 15 minutes.

e. The recorder chart or tape shall become the property of the Government.

f. The recorder shall be placed in a position convenient for observation by the concrete plant operator and the Government inspector.

g. The recorded weights or volumes when compared to the weights or volumes actually batched shall be accurate within plus or minus 2 percent.

2.3.5.9 Batch Counters

The plant shall include devices for automatically counting the total number of batches of all concrete batched and the number of batches of each preset mixture.

[2.3.5.10 Rescreening Plant

A rescreening plant shall be located, arranged, and operated in a manner that all coarse aggregate will be routed through the plant and that its operation will ensure delivery to the mixers of graded coarse aggregate free from variation and conforming to the size groups and grading of paragraph AGGREGATES above and with moisture content conforming to the provisions of paragraph TESTS AND INSPECTIONS in PART 3. Coarse aggregate may be rescreened and delivered to the batch plant bins one size group at a time or two or more adjacent size groups at a time. Simultaneous rescreening of nonadjacent size groups is not permitted. All material passing the bottom screen of the smallest size of coarse aggregate being screened shall be wasted.

][2.3.5.11 Washing Plant

All coarse aggregates shall be washed immediately prior to entering the rescreening plant. The washing plant shall contain adequate water nozzles and vibrating screens to remove foreign materials and coatings from aggregate particles. Water used for washing shall meet the requirements of paragraph WATER above.

]2.3.5.12 Batch Plant Trial Operation

Not less than 7 days prior to commencement of placing the test section, a test of the batching and mixing plant shall be made in the presence of a representative of the Contracting Officer to check operational adequacy. The number of full-scale concrete batches required to be produced in trial runs shall be as directed, will not exceed 20, and shall be proportioned as directed by the Contracting Officer. All concrete produced in these tests shall be wasted or used for purposes other than inclusion in structures covered by this specification. All deficiencies found in plant operation shall be corrected to the satisfaction of the Contracting Officer prior to the start of concrete placing operations. No separate payment will be made to the Contractor for labor or materials required by provisions of this paragraph. Mixer uniformity testing, in accordance with paragraph TESTS AND INSPECTIONS in Part 3, will be performed by the government near the end of this trial operation period. Notify the Contracting Officer of the trial operation not less than 7 days prior to the start of the trial operation.

2.3.5.13 Protection

The weighing, indicating, recording, and control equipment shall be protected against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

2.3.6 Continuous Mixing Plant(s)

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NOTE: See the concrete materials DM or consult the materials engineer to fill in the blanks.

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A continuous mixing plant(s) shall be capable of producing RCC of the same quality and uniformity as would be produced in a conventional batch plant and shall be capable of producing a uniform continuous product (at both maximum and minimum production rates) that is mixed so that complete intermingling of all ingredients occurs without balling, segregation, and

wet or dry portions.

2.3.6.1 Operation and Accuracy

An electronic control system shall be provided. The control system shall have the capability of changing mixtures instantaneously, producing at least [_____] different mixtures, producing any of the mixtures at a variable rate, and tracking a mixture change to a hopper or a conveyor system. The control panel shall display for each ingredient the designed formula values and the instantaneous percentage values and shall record the instantaneous values at a preset time interval or on demand with a multiple copy printer/recorder. The recorder shall note formula changes and shall print total quantities of each ingredient and total amounts produced on command. There shall be weighing devices (belt scale or other) for continuous weighing of individual ingredients and total ingredients. The plant control shall not require manual devices to adjust the material flow. The plant shall be capable of total manual control operation for a single product at a limited production for short-time durations in the event of loss of electronic control. The electronic control system shall incorporate modular replaceable components to reduce down time in the event of control system malfunction. An inventory shall be maintained of such replaceable components. The fine aggregate shall have a device that monitors its content immediately prior to dispensing into the mixing plant dispensing system. The accuracy of the plant dispensing systems shall be within the following limits:

MATERIAL	PERCENT OF REQUIRED MASS
Pozzolan	0 to +2 percent
Cement	0 to +2 percent
Water	± 1 percent
Aggregate smaller than 37.5 mm 1-1/2 inch size	± 2 percent
Aggregate larger than 37.5 mm 1-1/2 inch size	± 3 percent
Admixtures	0 to +6 percent
Note: The continuous feeders for each of the ingredients shall be calibrated in accordance with the manufacturer's specifications. Devices and tools shall be maintained at the plant location to check the feeder's calibration at the Contracting Officer's request. A technician shall be provided that is skilled in calibration of the feed devices and the maintenance and repair of the plant control system. The technician shall be available within 30 minutes notice during all scheduled plant operations. The technician could be one or more of the Contractor's personnel.	

2.3.6.2 Cement, Pozzolan, and Aggregate Feed

Cement, pozzolan, and aggregate shall be uniformly, continuously, and simultaneously fed (at the proper ratios and quantity for the mixture required) into the mixer by belt, auger, vane feeder, or other acceptable method. The feed bins or silos for each ingredient shall be kept sufficiently full and shall be of sufficient size to ensure a uniform flow at a constant rate for a specific mixture. The feed bins shall have a low-level indicator that both warns the operator and can shut the plant down if insufficient material is available for a uniform and continuous

flow.

2.3.6.3 Water and Admixture Dispensers

The liquid-dispensing devices shall be capable of metering and dispensing within the specified requirements. The liquid valves shall be free from leakage in the closed position. The dispensers shall have attachments and/or be installed in such a manner that will permit convenient checking of their accuracy. Plumbing shall be leak-free and properly valved to prevent backflow and siphoning. The dispenser shall be interlocked with the electronic plant control and shall warn the operator and shut down the plant if insufficient liquid is available. Separate nozzles for each liquid shall be properly located at the mixer to assure uniform distribution of each liquid to the materials entering the mixer.

2.3.6.4 Continuous Mixer(s)

The continuous mixer(s) shall have proper introduction of ingredients as specified by the manufacturer and shall not be charged in excess of the manufacturer's recommended capacity. Mixer(s) shall be capable of combining the materials into a uniform homogeneous mixture and of discharging this mixture without segregation. The mixer(s) shall operate at the blade speed designated by the manufacturer and shall be capable of changing retention time of the ingredients in the mixer. This should be accomplished by manually resetting the mixer(s) blade angles. Mixing time (ingredient retention time in the mixer) shall be predicated upon the uniformity, homogeneity, and consistency of the resultant mixture. Samples for uniformity testing shall be taken at 2-minute intervals and tested in accordance with COE CRD-C 55 and paragraph MIXER UNIFORMITY REQUIREMENTS below. The mixer(s) shall be maintained in satisfactory operating condition and mixer blades shall be kept free of hardened concrete. Should mixer(s) at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired. Suitable facilities shall be provided for obtaining representative samples of concrete for testing. All necessary platforms, shelters, tools, labor, and equipment shall be provided for obtaining samples.

2.3.6.5 Segregation

A means shall be used to reduce and minimize segregation and waste which would otherwise result from the continuous stream of concrete being fed into the batch haul devices (concrete buckets, dump trucks, etc.). The equipment shall retain the concrete between tracks or other means of transport to prevent the need for stopping the mixer. These devices could include, but not be limited to, small-volume conveyor discharge hopper with a large gate that is automatically opened on a timed interval, thereby dumping a series of small batches into larger batch hoppers, trucks, or truck beds

2.3.6.6 Trial Operation

Not less than 7 days prior to commencement of concrete placing, a test of the plant shall be made in the presence of a representative of the Contracting Officer to check operational adequacy. The number of cubic meters yards required to be produced in trial runs shall be as directed, but will not exceed 40 cubic meters 50 cubic yards and shall be proportioned as directed by the Contracting Officer. All concrete produced in these tests shall be wasted or used for purposes other than inclusion in structures covered by this specification. All deficiencies

found in plant operation shall be corrected to the satisfaction of the Contracting Officer prior to the start of concrete placing operations. Mixer uniformity tests by the Government will be performed near the end of this trial period. No separate payment will be made to the Contractor for labor or materials required by provisions of this paragraph. Notify the Contracting Officer of the trial operation not less than 7 days prior to the start of the trial operation.

2.3.6.7 Protection

The weighing, indicating, recording, and control equipment shall be protected against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

2.3.7 Laboratory Areas

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NOTE: The specification writer should use this paragraph unless a laboratory building is to be government furnished.
****

A [room] [separate building] shall be provided adjacent to the plant to house the moisture and grading testing equipment for aggregate and to provide working space for the Government representative. Another room shall be provided for testing fresh concrete and for fabricating and initial curing (approximately 72 hours) of concrete test specimens in accordance with ASTM C31/C31M. The size, arrangement, and location of these rooms will be subject to approval by the Contracting Officer. Provide electricity, air-conditioning, heat, and water as required for use in these laboratory areas.

2.3.8 Mixers

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NOTE: See the concrete materials DM for information on mixer selection and concrete mixers. Truck mixers shall not be allowed for mixing or transporting RCC or conventional concrete with less than 50 mm 2 inch slump or greater than 38 mm 1-1/2 inch nominal maximum size aggregate (NMSA).
****

Mixers shall be stationary mixers or pugmill mixers. [Truck mixers may be used for conventional concrete]. Mixers may be batch or continuous mixing. Each mixer shall combine the materials into a uniform mixture and discharge this mixture without segregation. Mixers shall not be charged in excess of the capacity recommended by the manufacturer on the nameplate. Excessive overmixing requiring additions of water will not be permitted. The mixers shall be maintained in satisfactory operating condition, and mixer drums shall be kept free of hardened concrete. Mixer blades or paddles shall be replaced when worn down more than 10 percent of their depth when compared with the manufacturer's dimension for new blades. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired or replaced.

[2.3.9 Truck Mixers

Truck mixers and the mixing of concrete therein shall conform to the

requirements of ASTM C94/C94M. A truck mixer may be used for conventional concrete complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters from which it shall be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. Truck mixers shall not be used to mix or agitate concrete with greater than 37.5 mm 1-1/2 inches NMSA or concrete with a slump of 50 mm 2 inches or less. The acceptability of truck mixers for uniform mixing shall be determined by uniformity tests in accordance with ASTM C94/C94M.

]2.3.10 Pugmill Mixers

A batch or continuous mixing twin-shaft pugmill mixer shall be capable of producing RCC of the same quality and uniformity as would be produced in a conventional plant that meets all the requirements of these specification. All pugmill mixers shall meet the requirements of paragraph CONTINUOUS MIXING PLANT(S) above.

2.3.11 Mixer Uniformity Requirements

All mixers, except for truck mixers, will be tested by the Government in accordance with this paragraph and in accordance with COE CRD-C 55. When regular testing is performed, the conventional concrete shall meet the limits of any five of the six applicable uniformity requirements, and the RCC shall meet the limits of any three of the four applicable uniformity requirements. When abbreviated testing is performed, the concrete shall meet only those requirements listed for abbreviated testing. The initial mixer evaluation test shall be a regular test and shall be performed prior to the start of concrete placement. The concrete proportions used for the evaluation shall contain the largest size aggregate on the project and shall be as directed by the Contracting Officer. Regular testing shall consist of performing all tests on three batches of concrete. The range for regular testing shall be the average of the ranges of the three batches. Abbreviated testing shall consist of performing the required tests on a single batch of concrete. The range for abbreviated testing shall be the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, etc., the results of tests on one of the mixers shall apply to the others, subject to the approval of the Contracting Officer. Mixer evaluations shall be performed by the Government. Provide labor and equipment as directed by the Contracting Officer to assist the Government in performing the tests.

PARAMETER	REGULAR TESTS ALLOWABLE MAXIMUM RANGE FOR AVERAGE OF 3 BATCHES	ABBREVIATED TESTS ALLOWABLE MAXIMUM RANGE FOR 1 BATCH
Unit weight of air-free mortar, 1)	16 kg/cu m2.0 lb/cu ft	16 kg/cu m2.0 lb/cu ft
Air content	1.0 percent	--
Slump, 1)	25 mm1 inch 1.0	--

PARAMETER	REGULAR TESTS ALLOWABLE MAXIMUM RANGE FOR AVERAGE OF 3 BATCHES	ABBREVIATED TESTS ALLOWABLE MAXIMUM RANGE FOR 1 BATCH
Coarse aggregate, 1),2)	6.0 percent	6.0 percent
Compressive strength at 7 days, 1),2)	10.0	10.0
Water content, 1), 2)	1.5 percent	1.5 percent
Consistency, modified Vebe, 2) second	7.0	--
Note: 1) = Test for conventional concrete mixed in stationary mixer, 2) = Test for RCC		

A regular test will be performed before concrete production begins and when the Contractor requests a reduced mixing time. An abbreviated test shall be performed every 3 months when concrete is being placed. If a mixer fails the abbreviated test, a regular test will be performed. Cost of testing when the Contractor requests a reduced mixing time will be paid by the Contractor.

2.3.12 Sampling Facilities

2.3.12.1 Sampling Concrete

Provide suitable facilities and labor for obtaining representative samples of concrete in accordance with ASTM C172/C172M for Contractor quality control and Government quality assurance testing.

2.3.12.2 Sampling Aggregates

Suitable facilities shall be provided for readily obtaining representative samples of aggregates for test purposes immediately prior to the material entering the mixer.

2.3.13 Transporting and Conveying Equipment

The transporting and conveying equipment shall conform to the following requirements.

a. The concrete mixtures (RCC, bedding mortar, concrete, and any other concrete that will interface with the RCC) shall be conveyed from the plant mixer(s) to placement as rapidly and as continuously as practical by methods which limit segregation, contamination, and surface drying.

b. The RCC shall be conveyed from the mixing plant to the structure by means of main-line conveyor, end-dump truck, front-end loader, or a combination thereof.

c. Conventional concrete may be transported by ready-mix truck, conveyor, or agitator truck, or properly designed nonagitating truck.

d. Indicating and signaling devices shall be provided for the control and

identification of types or classes of concrete as they are mixed and discharged for transfer to the placement site.

e. Each type or class of concrete shall be visually identified by placing a colored tag or other marker as it leaves the mixing plant so that the concrete may be positively identified and placed in the structure in the desired position.

2.3.13.1 Trucks

Truck mixers or agitators used for transporting central-mixed conventional concrete shall conform to the applicable requirements of ASTM C94/C94M. Truck mixers shall not be used to transport concrete with larger than 37.5 mm 1-1/2-inch nominal maximum size aggregate (NMSA) or 50 mm 2 inch slump, or less. Nonagitating trucks may be used for transporting conventional central-mixed concrete over a smooth road when the hauling time is less than 15 minutes and the slump is less than 75 mm 3 inches. Bodies of nonagitating trucks shall be smooth, water-tight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation.

2.3.13.2 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer or delivery truck to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete or loss of mortar at transfer points and the point of placing. The NMSA required in mixture proportions furnished by the Government will not be changed to accommodate the belt width.

2.3.14 Spreading and Remixing Equipment

The spreading and remixing equipment shall conform to the following requirements:

a. The primary spreading procedure shall be accomplished by dozer. Graders or other equipment not specified may be used to facilitate the RCC spreading process only when approved.

b. For open, unrestricted areas, the dozer shall be a minimum size and weight equivalent to a Caterpillar D-6. For restricted placement areas, such as placement of RCC near the dam crest or next to abutments, the dozer shall have as a minimum a size and weight equivalent to a Caterpillar D-4.

c. A minimum of one operating dozer for each 150 cubic meters 200 cubic yards of RCC placed each hour. The dozers shall be equipped with well maintained grousers. A front-end loader with operator shall be available to assist with deposition and spreading of RCC as needed in confined areas.

d. The equipment shall be maintained in good operating condition. The equipment shall not leak or drip oil, grease, or other visible contaminants onto the RCC surface.

e. All equipment used for spreading and remixing that leaves the surface of the structure for maintenance or repairs or, for any other reason, shall be cleaned of all contaminants by an approved method before

returning to the structure surface. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC except to facilitate startup operations for each lift and by approved procedures.

2.3.15 Compaction Equipment

Submit a listing of the equipment proposed for transporting, handling, depositing, spreading, and compacting the concrete for review by the Contracting Officer [[_____] days before concrete placement begins.] [not later than 30 days after Notice to Proceed.] Include site drawings or sketches with locations of equipment and placement site. The compaction equipment shall conform to the following requirements.

2.3.15.1 Primary Rollers

Self-propelled vibratory rollers shall be used for primary rolling and shall be double-drum. They shall transmit a dynamic impact to the surface through a smooth steel drum by means of revolving weights, eccentric shafts, or other equivalent methods. The compactor shall have a minimum gross mass of 9000 kg 20,000 pounds and shall produce a minimum dynamic force of 60 000 N/m 350 pounds/linear inch of drum width. The operating frequency shall be variable in the approximate range of 1,700 to 3,000 cycles per minute. The amplitude shall be adjustable between 0.4 and 1.0 mm 0.015 and 0.04 inches. The roller shall be capable of full compaction in both forward and reverse directions. The roller shall be operated at speeds not exceeding 0.7 m/s 2.2 ft/s. Within the range of the operating capability of the equipment, the Contracting Officer may direct or approve variations to the frequency, amplitude, and speed of operation which result in the specified density at the fastest production rate.

2.3.15.2 Small Vibratory Rollers

Small vibratory rollers shall be used to compact the RCC where the larger vibratory rollers specified above cannot maneuver. The rollers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Small vibratory rollers cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when small rollers are used, total lift thickness of the RCC layer or lift shall be reduced to not over 150 mm 6 inches uncompacted thickness to permit adequate compaction. Rollers shall have independent speed and vibration controls and shall be capable of a wide range of speed adjustments.

2.3.15.3 Tampers (Rammers)

The tampers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Tampers cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when tampers are used, thickness of each RCC layer that is to be compacted shall be reduced to not more than 150 mm 6 inches uncompacted thickness to assure adequate compaction.

2.3.15.4 Other Requirements

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NOTE: See the concrete materials DM or the materials engineer to fill in the blanks.

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At least [_____] self-propelled vibratory rollers, at least [_____] small rollers, and at least [_____] tampers meeting these requirements shall be maintained full time at the site and ready for service at all times during production and placement.

2.3.16 Truck-Mounted Vacuum Pickup System

A truck-mounted vacuum pickup system shall be provided for various cleanup operations from the beginning of foundation cleanup to final placement of job RCC. The unit(s) shall be capable of pumping 125 cubic meters 4,500 cubic feet of air per minute through an 200-mm 8-inch diameter opening and capable of pumping water at a minimum rate of 125 L/s 2,000 gpm. The equipment shall be maintained in good operating condition. The equipment shall not leak cleanup water and other debris during equipment operation or transit. The equipment shall not leak or drip oil, grease, or other visible contamination onto the RCC.

2.3.17 Other Motorized Equipment

All other equipment (backhoe with vibratory plate, backhoe with immersion vibrators, backhoe with mandrel for inserting contraction joint plates, wash trucks, etc.) necessary for the successful completion of RCC production, but not previously discussed within these specifications (or determined to be necessary during the course of the work), shall be approved prior to actual use. Such equipment shall not result in any damage to the RCC, shall be maintained in good operating condition, and shall be operated by skilled contractor-provided personnel.

2.3.18 Nuclear Density Gauge

Tests to determine the density of both the uncompacted and compacted RCC shall be made by the Contractor using a two-probe nuclear density gauge supplied by the Contractor. The nuclear density gauge shall meet the applicable requirements of ASTM C1040/C1040M. The gauge shall be capable of taking readings along a horizontal path between the probes at 50-mm 2-inch increments from 50 mm 2 inches from the surface to 600 mm 24 inches below the surface. The gauge and operator shall be made available to the Government until completion of all RCC production at no additional cost. Obtain all permits and certifications for the equipment and the operators.

2.3.19 Calibration

Nuclear gauges shall have been factory calibrated within 6 months of RCC placement. Construct, at no additional costs to the Government, three conventional concrete test blocks using RCC coarse aggregates and RCC fine aggregate, and with dimensions 300 mm 12 inches larger than the gauge dimensions. The concrete shall be formulated to have densities of approximately 2100, 2300, and 2600 kg/cu m 130, 145, and 160 lb/cu ft using the RCC materials and so far as possible, similar relative proportions. Completed blocks shall be weighed and measured to determine unit weight. Gauge calibration constants shall be adjusted for performance on these blocks at least 7 days prior to the evaluation of test strips. Remedy any inconsistencies in gauge performance prior to the start of RCC placement. After the start of RCC placement, gauges shall be field recalibrated against cast blocks every 24 hours.

2.3.20 Vibrators

Internal vibrators of the proper size, frequency, and amplitude for the work being performed as indicated in the chart below shall be used to consolidate conventional concrete and the interface between conventional concrete and RCC. The vibrators for the conventional concrete/RCC interface shall consist of a minimum of four vibrators "gang-mounted" in a line on the boom of a backhoe or similar chassis. The gang-mounted vibrators shall be the large (80 to 150 mm) (3 to 6 inch) models of that listed below:

APPLICATION	HEAD DIAMETER (mm) (inch)	FREQUENCY (VPM)	AMPLITUDE (mm) (inch)
RCC interface	80 to 1503 to 6	7,000 to 10,500	0.75 to 1.50 0.03 to 0.06
General construction	50 to 902 to 3-1/2	8,000 to 12,000	0.65 to 1.25 0.025 to 0.05
Thin walls	32 to 651-1/4 to 2-1/2	9,000 to 13,500	0.50 to 1.00 0.02 to 0.04

Determine the frequency and amplitude in the presence of a Government representative in accordance with COE CRD-C 521.

[2.3.21 Slipforming Equipment

****
NOTE: Consult the materials engineer or the concrete materials DM for whether slipforming is to be allowed or required.
****

The slipforming equipment shall be capable of slipforming facing elements as specified at a minimum rate of 7.5 mm/s 1.5 ft/min. The slip-former shall have an automated guidance system which shall guide the slip-former within the specified tolerances. The slipformer shall have the capability of turning and guiding the form without damage to the RCC and facing element. The slipform mold shall be at least 1 m 3 feet long to allow the slipform to track easily and to minimize surface tearing caused by friction between the mold and the concrete. The mold shall be designed to be mortar-tight and to contain the concrete so that it can be fully consolidated.

]PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

****
NOTE: Refer to the appropriate DM and the project coordinator for filling in the correct dates and to choose the optional sentences.
****

3.1.1 Placing Schedule

RCC Placement for the main structure shall start no later than [_____] and no earlier than [_____]. Placement of all RCC shall be completed by

[_____]. Before starting RCC production, a detailed schedule shall be submitted indicating intended daily and weekly production rates that, when followed, will meet the beginning and ending specified RCC production dates. After initiation of RCC production, the Contractor's schedule shall be updated and adjusted on a weekly basis for the duration of the RCC placement. If it becomes apparent for any reason that the Contractor is not pursuing a schedule that will meet the specified RCC production dates, actions necessary to increase the production rate shall be taken so that production is once again on schedule, within [_____] calendar days after written notice. Also, if not back on schedule by the end of the [_____] days calendar period, the Government reserves the right at this time to direct the Contractor, at no additional cost to the Government, to increase the amount and size of crews and equipment.

3.1.2 RCC Orientation Session

Prior to or in conjunction with the construction of the RCC test section, supervisors and all other Contractor personnel which are expected to participate in the production of RCC for this job (including laborers, equipment operators, foremen, and QC and inspection staff) shall participate in a 2-hour orientation session organized by the Contracting Officer. Provide a facility suitable for slide and videotape presentation. The intent is to orient all individuals on the goals of the RCC placement process, provide clarification of specification requirements if requested, and be provided orientation as to what constitutes good construction practices. Additional orientation sessions will also be made available to, and shall be attended by, all new Contractor personnel who are subsequently hired and that will be involved with the production of the RCC.

3.1.3 Aggregate Production Schedule

****

NOTE: See the appropriate DM or the materials engineer to fill in the blanks.

****

Aggregate production and initial stockpiling shall begin and shall be producing acceptable material by not later than [_____] days in advance of the time when placement of the RCC test section is expected to begin. At least [_____] percent of all RCC aggregates for each size group necessary for the completed RCC construction shall be manufactured and stockpiled prior to start of placement of RCC for the permanent RCC structures. Submit descriptions and details for all methods and operations proposed for aggregate and concrete operations including daily and weekly production rates, [not later than [_____] days after Notice to Proceed] for review and approval for conformance with specifications.

3.1.4 RCC Test Section

****

NOTE: See the materials engineer for information for filling in the blanks.

****

Prior to placement of any RCC, construct a test section. The purpose of the test section is to demonstrate the suitability of the Contractor's equipment, methods, and personnel. The test section shall be at least [5] [_____] lifts in height and be at least [60] [_____] m [200] [_____] feet

long and [12] [_____] m [40] [_____] feet wide at the top. The site of the test section shall be approved. After evaluation and assessment of the test section by the Contracting Officer, dispose of the test section in an approved manner. Under no circumstances shall the test section be incorporated into or become a part of the permanent RCC structure. The test section shall demonstrate sustained plant production rates, and batching, mixing, transporting, spreading, and compaction procedures. It shall also demonstrate the vertical face construction method along one side, the sloped face construction method along another side, procedures for foundation and concrete surface preparation and cleanup, procedures for placement of bedding concrete, bedding mortar, and other conventional concrete, and the installation of any contraction joints and waterstops. Do not begin RCC operations for the main structure until testing and evaluations by the Government have been completed, and it has been demonstrated to the satisfaction of the Contracting Officer that all specification requirements were met. Following completion of test section construction, [10] [_____] calendar days shall be allowed for testing and evaluations. If the Contractor does not meet requirements as specified, an additional test section or sections shall be constructed at no additional cost to the Government. The date of the test section construction shall be provided at least 7 days in advance.

3.1.5 Surface Preparation

3.1.5.1 Cleaning

All lift surfaces including any RCC, dental concrete, bedding concrete, bedding mortar, or other conventional concrete placed adjacent to and at the same time as the RCC shall be cleaned prior to placing any additional concrete thereon. After cleaning, bedding concrete and bedding mortar are to be used specifically for achieving bond between different types of concrete and/or foundation and eliminating and preventing segregation or voids along margins or RCC placements. No surfaces to receive bedding concrete or bedding mortar shall be covered with RCC until the prepared surfaces have been accepted in writing and that acceptance has been recorded on an approved checkout form. All surfaces upon which RCC or any bedding mortar or bedding mix is placed shall be moist (but contain no visible free water). Prior to placing any concrete adjacent to and at the same time as the RCC, all surfaces shall be clean and free of loose, unkeyed, or deteriorated rock; all mud and silt accumulations; vegetation; laitance; puddles or ponds of free surface water; coatings; and any other detrimental materials. High-pressure water jetting, and/or wet sandblasting, followed by mild high-volume, low-pressure washing, shall be used on all hardened concrete surfaces (cold joints) as necessary for the removal of laitance, coatings, stains, or other difficult-to-remove contaminants. High-volume low-pressure water washing and/or water jetting may be used for removal of loose materials. Adequate equipment with operators shall be on hand at the site to clean all surfaces in conformance with these specifications without disrupting in any way the RCC production as scheduled.

3.1.5.2 High-Volume Low-Pressure Washing

Washing of loose materials can be accomplished with high-volume low-pressure water washing and/or air water jetting using equipment of similar design to that used in large-scale foundation cleanups. The air-water jets shall have 40-mm 1-1/2-inch nozzles, a water supply of at least 2 L/s 30 gpm, and compressed air at the jet of 550 to 850 kPa 80 to 120 psi. The low-pressure water jets shall have 25-mm 1-inch nozzles

available and a capacity of at least 13 L/s 200 gpm for truck-mounted devices.

3.1.5.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 10.3 MPa 1,500 psi for RCC and 27.6 MPa 4,000 psi for conventional concrete shall be used for cleaning all cold joint surfaces, or surfaces with laitance, mortar coatings, stains, or other difficult-to-remove contaminants. There shall be no undercutting of coarse-size aggregates. Aggregate particles that are undercut shall be removed. For cleaning large open areas larger than [_____] square meters feet, the high-pressure water jet system shall be truck-mounted. For cleaning small or confined areas, the high-pressure water jet system shall be portable.

3.1.5.4 Wet Sandblasting

This method may be used when the RCC has reached sufficient strength to prevent undercutting of coarse aggregate particles. Wet sandblasting shall be continued until all accumulated laitance, coatings, stain, or other difficult-to-remove contaminants are removed. Wet sandblasting may be used in lieu of or in combination with the high-pressure water jet.

3.1.5.5 Waste Disposal

Any waste water employed in cutting, washing, and rinsing of concrete surfaces, and any other surface water shall not stain, or affect exposed surfaces of the structure(s) or damage the environment of the project area. The method of disposal shall be subject to approval.

3.2 PLACING

****
NOTE: Consult the concrete materials DM for the use of optional sentences and filling in the blanks.
****

3.2.1 Procedures

It is the intent of this contract to raise the structure at essentially the same level across the entire horizontal surface area. For a dam, placement shall proceed from abutment to abutment and from downstream to upstream. Each lift shall be completed in its entirety across the full surface of the mass. As the advancing edge of the lift progresses, the exposed leading edges shall be kept "live" by progressively placing out from the advancing edge in a sloping and uniform fan-like manner. RCC shall be deposited (from the conveyor, end-dump truck, or front-end loader) on the uncompacted RCC of the advancing edge in a forward direction from the dump pile. RCC shall not be placed in consecutive or consistent lanes. The dump location shall be varied to avoid "lane" construction. [See Contract Drawing [_____] showing typical depositing, spreading, and remixing operations.] The interval between batch plant mixing and final RCC compaction shall be no greater than 45 minutes for 300 mm 12 inch lifts and 75 minutes for 600 mm 24 inch lifts. Final compaction is defined as: Any RCC lift composed of layers that have been worked twice by dozer grousers, receives four passes with the vibratory roller, and meets the density requirements.

3.2.2 Bedding Mortar

The bedding mortar shall be applied to the existing surface following any required cleanup. The bedding mortar shall be applied not more than 15 minutes ahead of RCC placement, unless otherwise approved. The bedding mortar shall be used between hardened conventional concrete and RCC, between different RCC placements where cold joints occur, and other locations as directed or as shown in the drawings. The bedding mortar shall have an average thickness after application of between 6 and 13 mm 1/4 and 1/2 inch and shall cover 100 percent of the lift area.

3.2.3 Bedding Concrete

The bedding concrete, a conventional concrete mixture, shall be used at the abutment-RCC interface, and except for cast-in-place concrete for the upstream face, between the RCC and any formed sloping or vertical surface and other locations as directed or as shown in the drawings. Placement of the bedding mixture shall occur only after all required surface preparations have been completed.

3.2.4 Lift Thickness

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NOTE: See the concrete materials DM for the lift thickness.

****

The total lift thickness after final compaction by the vibratory roller shall be [300] [_____] mm [12] [_____] inches.

3.2.5 Depositing, Spreading, and Remixing

****

NOTE: See the appropriate Design Memorandum for use of the alternate optional paragraphs below.

****

After the RCC has been deposited, the RCC shall be spread by dozers into gently sloping layers, approximately 150 mm 6 inches thick, that will, after final compaction of the several layers by the vibratory roller, result in the specified lift thickness. During the spreading process, the dozer operators shall continuously work the RCC surfaces with the dozer blade and grousers in a manner to remix any RCC that may contain pockets of segregated material and to compact the material. All surfaces of each layer shall receive at least two passes with the grousers. The dozers shall be operating continuously during the spreading process, even if this action results in more than two passes. A front-end loader with operator shall be available to assist with depositing and spreading RCC as needed in confined areas, at the abutments, and at other locations approved or directed. In no case shall the RCC, bedding mixes, or bedding mortar be allowed to dry. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC except at the start of each lift placement to facilitate startup operations, and then only by an approved procedure. No RCC or other concrete shall be placed on a previous lift which has not met specification. Unacceptable material shall be removed.

3.2.6 Compaction/Consolidation

After spreading and working with the dozers, the top surface of each lift shall be compacted with a minimum of four, plus as many additional passes with a self-propelled double-drum vibratory roller operating in the vibratory mode as are required to obtain a minimum of 98 percent of the theoretical density. A round trip over the same material shall count as two passes (i.e., from point A to point B and return to point A by the same route is two passes). Rollers shall not be operated in the vibratory mode unless they are moving. Bedding concrete and any other conventional concrete that interfaces with the RCC shall be consolidated with internal vibrators.

3.2.6.1 Theoretical Density (TD) Determination

****
NOTE: See the appropriate DM to fill in the blanks.
****

The TD is defined as the theoretical density (unit weight) of the concrete, kg pounds per cubic meter foot, computed to include an air content of [_____] percent. The TD value to be used during construction will be determined using job mixture proportions and Contractor supplied materials; and, using compaction techniques suitable for RCC, and following the appropriate testing procedures used to determined theoretical unit weight of concrete as described as in ASTM C138/C138M.

3.2.6.2 Required Compaction Density

All RCC shall be compacted to a minimum of 98 percent of the TD value. The anticipated TD, estimated from laboratory test data is approximately [_____] kg pounds per cubic meter foot.

3.2.6.3 Density Determination of Compacted RCC

Density shall be measured using a nuclear density meter in accordance with ASTM C1040/C1040M. RCC density value determinations shall be made throughout the course of RCC placement to assure that the RCC is compacted to a minimum 98 percent of the TD and detect segregation and/or voids throughout the RCC.

3.2.6.4 Additional Compaction

If more than four passes are required to achieve the required density, the additional passes shall be made at no additional cost to the Government.

3.2.6.5 Consolidation of Bedding and Other Conventional Concrete

In no case shall vibrators be used to transport concrete. The vibrator shall be inserted vertically at uniform spacing over the entire area of conventional concrete placement area. The distance between insertions shall be approximately one and one-half times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 150 mm 6 inches into any preceding plastic layer if such exists. The vibrator shall be held stationary until the entrapped air is forced to the surface (up to 6 seconds) and the concrete is consolidated and then withdrawn slowly. An adequate number of vibrators shall be on hand to meet placing requirements, and spare vibrators shall be available to maintain production in the event of breakdown.

3.2.7 Lift Joints

The entire RCC mass shall be placed with sufficient continuity so that it hardens and acts as one monolithic block without discontinuous joints or potential planes of separation. All lift joints shall be kept clean, uncontaminated, free from ponded water, and continuously moist until placement of the succeeding RCC or other concrete.

3.2.7.1 Regular Lift-Joint Treatment

Lift joints that have not hardened or dried and are less than 72 hours old shall be given the regular lift-joint treatment. Submit the method and equipment proposed for joint cleanup and waste disposal for review by the Contracting Officer [[_____] days before concrete placement begins] [not later than [_____] days after Notice to Proceed] for conformance with specifications. Regular lift-joint treatment and maintenance shall include:

a. Maintaining 100 percent of each compacted lift-joint surface continuously moist,

b. If necessary, removing all loose contaminants or deteriorated RCC by low-pressure washing and/or vacuuming, and

c. Application of a 6 to 13 mm 1/4 to 1/2 inch thick bedding mortar over the entire placement surface area immediately before placement of the next lift.

For regular lift-joint treatment, no washing or vacuuming will be necessary provided damage or contamination of the lift surface is prevented.

3.2.7.2 Cold Joints

A cold joint is any vertical or horizontal RCC surface:

a. That does not receive the next RCC lift within 72 hours,

b. In which the RCC has been allowed to dry, or

c. That has been contaminated to the extent that contaminants cannot be removed using low-pressure water.

Cold joints shall be prepared for the next lift by the methods and procedures in paragraph SURFACE PREPARATION above, prior to resumption of RCC placement. Following this initial preparation, the cold-joint surface shall be kept continuously moist until application of the bedding mortar. Whenever a cold joint at any edge or end of any lift occurs, it shall be located at least 10 m 30 feet from the location of other cold joints that may have previously occurred in the same direction along previous lifts.

3.2.7.3 Vertical Joints

Joints for sloping, near-vertical or vertical RCC surfaces are considered to be vertical joints. A vertical joint most often will occur when an RCC placement is terminated before the entire RCC placement for that lift has been completed. When it does become apparent that placement of RCC will be terminated prior to completion of a lift, the RCC spreading procedure

at the leading zone of the placement shall be adjusted to provide a gradual tapered slope to complete that lift. The taper shall be no steeper than 25 horizontal on 1 vertical. Where the tapered slope meets the underlying hardened lift surface, care shall be taken to prevent or remove any segregated or uncompacted material. The tapered surface shall be compacted in accordance with paragraph COMPACTION/CONSOLIDATION above. Prior to resumption of RCC placements, the tapered surface shall be prepared in accordance with paragraph SURFACE PREPARATION above.

3.2.8 Downstream Face

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NOTE: See the concrete materials DM to select one of the two optional systems for the downstream face.
****

[3.2.8.1 Using Sacrificial Concrete

The downstream sloped face of the dam and the exposed slopes of the stilling basin training walls shall be constructed using sacrificial RCC on [[_____] vertical to [_____] horizontal slope] [1 vertical to 0.85 horizontal slope]. The slope shall be constructed to the tolerances specified. Each RCC lift shall be overbuilt at least 300 mm 12 inches, and it shall subsequently be trimmed to the surface smoothness tolerance. Trimming shall be performed before the RCC is more than 48 hours old. The process shall be demonstrated during the test section. Trimming shall be done in such a manner to prevent damage to the surface and interior RCC.

][3.2.8.2 Using Conventional Concrete

The downstream face shall be constructed of conventional concrete in accordance with paragraph VERTICAL FACINGS FOR RCC CONSTRUCTION below.

]3.3 CURING AND PROTECTION

Submit the curing media and methods to be used for review to the Contracting Officer [[_____] days before concrete placement begins] for conformance with specifications.

3.3.1 Curing

The surface of every RCC lift shall be kept continuously moist, commencing immediately after compaction, by use of water trucks equipped with fog sprayers for 14 days or until the surface is covered with the next lift. The sloping downstream surface of the Dam, [and the [_____]] if constructed of uncompacted sacrificial RCC, need not be cured. Curing and protection for all conventional concrete used in the construction of the vertical faces and any horizontal RCC surfaces that will not receive a subsequent concrete covering shall be moist cured. Conventional concrete made with Type II portland cement, or any type of portland cement with pozzolan, and all RCC shall be moist cured for 14 days. Conventional concrete made with Type I portland cement shall be moist cured for 7 days. Conventional concrete shall be moist cured by covering with saturated nonstaining burlap or cotton mats. New burlap or cotton mats shall be rinsed to remove soluble substances before using. Concrete that is moist cured shall be maintained continuously, not periodically, wet for the duration of the entire curing period. Water for curing shall comply with the requirements of paragraph WATER in PART 2. If the water or mats cause staining or discoloration of permanently exposed concrete surfaces,

the surfaces shall be cleaned by a method approved by the Contracting Officer. When wood or metal forms are left in place during curing, the forms shall be kept continuously wet, except for sealed insulation curing in cold weather. RCC may be cured with saturated cotton or burlap mats in lieu of the approved fog spraying equipment.

3.3.2 Cold-Weather Protection

****
NOTE: See the concrete materials DM or thermal study for the optional numbers.
****

The air and forms in contact with the RCC and any conventional concrete shall be maintained at a temperature above 0 degrees C 32 degrees F for [14] [_____] days. In addition, at the time insulation or protection is removed, the air temperature adjacent to the RCC surfaces shall be controlled so that the concrete near the surface will not be subjected to a temperature differential of more than 15 degrees C 25 degrees F (as determined by observation of ambient air and concrete temperatures). Submit a description of the materials and methods proposed for protection of the concrete, when concrete is to be placed under cold-weather conditions, to the Contracting Officer for review [_____] days in advance of anticipated need date.

3.3.3 Special Cold-Weather Insulation Protection

****
NOTE: See the appropriate DM for use of this paragraph and to fill in the blanks.
****

In addition to the requirements specified above, all RCC and any conventional concrete placed at the same time and in direct contact with the RCC shall receive special insulation protection as described for the following time periods:

a. [_____].

b. [_____].

The insulation shall provide an R value not less than [_____] square meter degree Celsius per watt hour square foot degree Fahrenheit per BTU.

3.3.4 Hot-Weather Protection

When ambient air temperatures exceeds 30 degrees C 90 degrees F and as soon as the conventional concrete and RCC is sufficiently hard to withstand washing of surface mortar, water by fog spraying shall be applied in a controlled manner to provide evaporative cooling. Water shall be applied at such a rate that it quickly evaporates and such that the surface remains continuously moist without ponding. In addition, when surface materials begin to dry and while the RCC placement, spreading, and compaction process is still underway and until the concrete has sufficiently hardened to permit the above water spray, hand-held fog spraying shall be applied to the concrete surfaces as directed to prevent drying out of concrete materials and replace moisture lost to evaporation. These hot-weather protection procedures will require additional labor(s) to assure complete coverage of the entire surface

areas to prevent unacceptable damage to the RCC and conventional concrete. Submit a description of the materials and methods proposed for protection of the concrete, when concrete is to be placed under hot-weather conditions, to the Contracting Officer for review [_____] days in advance of anticipated need date.

3.4 VERTICAL FACINGS FOR RCC CONSTRUCTION

****

NOTE: See the concrete materials DM to select the appropriate method or methods specified below. It should be noted that the method used for other vertical conventional concrete work may be different from the method used for construction of the upstream face. See paragraphs GALLERY and SPILLWAY CONSTRUCTION, below.

****

The vertical faces of the RCC structure are to be constructed using [a form and cast-in-place conventional concrete system] [a slipform facing system] [a precast concrete panel system] as shown and specified. Submit details of the construction methods and equipment for review within [_____] days after Notice to Proceed. The vertical facings system shall be demonstrated on one side of the RCC test section.

[3.4.1 Form and Cast-in-Place Conventional Concrete

Vertical and near-vertical facings shall be as shown in the drawings. The contract drawings are based on designs whereby all vertical and near-vertical faces are constructed of conventional slump concrete at the same time and rate as used in placement of each RCC lift. In construction of vertical facings, a 0.75 to 1.25 meter 2.5 to 4.0 foot wide zone of conventional concrete shall be placed against the forms or other hard surface. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. The formwork shall be designed for loads, lateral pressure, and allowable stresses in accordance with Chapter 1 of ACI 347R. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances. The required sequence of construction operations after all forms and concrete surface preparations have been approved is: place conventional concrete full height of each RCC lift and full width against the forms; using dozer action, spread each thin RCC layer into and abutting against the conventional concrete while at the same time tracking the interface between the two with dozer grousers; after full-lift thickness of the RCC is in place next to the conventional concrete, consolidate 100 percent of the conventional concrete and the interface; and finally, compact the RCC (to include the interface) using the vibratory roller. The interface between the RCC and conventional concrete shall be consolidated and "knitted" together using the gang heavy-duty, machine-mounted, immersion vibrators. Extreme care shall be taken to stage activities to assure all time restrictions are met and to prevent the occurrence of any openwork, honeycombing, or voids at the conventional concrete/RCC interface. All conventional concrete and bedding concrete placed along the RCC and the interface shall be thoroughly consolidated and intermixed by use of immersion vibrators. The Contractor's construction techniques and equipment used shall be satisfactorily demonstrated during construction of the test section.

][3.4.2 Slipformed Facing Elements

A slipformed conventional concrete face shall be constructed on the upstream face of the dam [and [_____]]. Concrete for the slipformed facing elements shall conform to requirements of this section. The configuration for the facing elements shall be as shown. The concrete mixture for the facing elements shall be proportioned by the Contractor to be formed by a slipform curbing machine and to have sufficient early strength to allow compaction for RCC against its surface within 4 hours.

3.4.2.1 Prequalification of Equipment

Prior to placing any slipformed facing elements for incorporation into the dam, a demonstration of the slipform equipment and concrete mixture as a part of the test section shall be performed by the Contractor. Form one side of the test section using his proposed slipforming equipment, in accordance with paragraph RCC TEST SECTION above. If necessary, adjust the concrete mixture and make any adjustments or modifications to the slipforming equipment and concrete supply procedures and equipment as may be required to produce a satisfactory slipformed facing element. A starting block shall be constructed to enable the first facing element to be formed without modification to the slipform.

3.4.2.2 Slipform Operations

The equipment shall be operated in such a manner as to prevent damage to the RCC surface and facing element. The slipformer shall carry a surge hopper of sufficient capacity to enable the slipformer to continue to extrude facing element between concrete deliveries. If the slipformer is stopped, concrete shall be thoroughly consolidated, a joint shall be made, and unacceptable concrete shall be removed from the mold. The slipformer shall have an automated guidance system which shall guide the slipformer within the specified tolerances. A smooth, mortar-tight joint between successive elements shall be achieved. Molds and vibrators shall be available in sufficient quantities to replace worn or damaged ones. Vibrators shall be capable of being adjusted and relocated to achieve complete consolidation.

3.4.2.3 Slipforming - Preparation for Placing

Placement shall not begin until after all preparations are complete and the authorized representative of the Contracting Officer has approved in writing completion of all preparations for that placement. No facing element concrete shall be placed until the surfaces to receive facing element concrete are free of deleterious substances including but not limited to: uncompacted, loose, deteriorated, or improperly cured RCC or facing element concrete, laitance, dirt, ice, curing compounds, and visible free surface water.

3.4.2.4 Slipforming - Placing

All joint surfaces more than 24 hours old, or in any other way damaged or not meeting the specification requirements, shall be wet sandblasted, washed with air-water jets, and surface dried prior to placement of adjoining facing elements. The molds for the slipform shall be kept continually full, and concrete vibrated, to prevent voids. The slipformed facing element shall be uniform, dense, and free of surface blemishes and tears.

3.4.2.5 Slipforming - Finishing

The class of finish and the requirements for finishing of slipformed facing elements shall be as specified in this paragraph, paragraph CONSTRUCTION TOLERANCES in PART 1, and as indicated. The finished surface shall be smooth and free from rock pockets and surface voids. Light surface pitting (voids up to 6 mm 1/4 inch diameter) and light slipforming marks are not considered objectionable. Where the surface produced meets specified requirements, no further finishing operations will be required.

][3.4.3 Precast Reinforced Panels

Design the precast panel systems as specified in [Section 03 41 33 PRECAST STRUCTURAL PRETENSIONED CONCRETE] [03 45 00 PRECAST ARCHITECTURAL CONCRETE] [03 45 33 PRECAST [PRESTRESSED] STRUCTURAL CONCRETE] [_____]. Typical panel systems shall consist of interlocked panels measuring 1 m 4 ft by as much as 5 m 16 ft, 4 inches thick (min.), and anchored at four locations. Anchor bars, straps, and connections shall be oversized or treated to compensate for deterioration due to exposure to moisture. Panels shall be adequately braced with either external strongbacks or by staggering panel placement and connection to adjacent panels. Bby design, assure the safety and immobility of the panel system. The panel system shall include upstream face [, downstream face] [, spillway crest] [, spillway training wall] [, and stilling basin training wall panels]. Panel joints shall match with pier noses, spillway cap, intake structure, and transverse joints.

3.4.3.1 Leveling Pad

No concrete leveling pad for setting panels is required unless the panel design so requires, however, the base of the panels shall be embedded at least 300 mm 1 foot into concrete, RCC, or backfill material. The initial row of panels shall be adequately braced, aligned, and leveled.

3.4.3.2 Alignment

Install panels so that horizontal joint lines of the upstream and downstream faces and the spillway crest panel joints align and meet the tolerances in paragraph CONSTRUCTION TOLERANCES.

]3.5 CONTRACTION JOINTS

****
NOTE: See the appropriate DM to fill in the blanks.
****

Contraction joints shall be formed by inserting plates into non-compacted full lift thickness RCC at locations as shown on the drawings. The plates, when installed adjacent to each other (at the same structure stationing within each lift) shall form a bond breaker that serves as a contraction joint. The plates shall be [900] [_____] mm [36] [_____] inches wide, [300] [_____] mm [12] [_____] inches deep, up to 6 mm 1/4 inch thick, and made out of [_____]. The plates shall be installed vertically into the RCC by means of a vibrating plate mounted on a backhoe. Submit the exact details for the design of the contraction joints, as well as installation and methods of maintaining tolerances, alignment, etc., within [_____] days after the Notice to Proceed. Plate alignment shall be controlled by laser or other approved survey technique. Waterstops, drains, and contraction joints within any conventional concrete shall be

in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE and as indicated.

[3.6 GALLERY

****
NOTE: See the concrete materials DM for use of this optional paragraph and to select the optional methods.
****

Submit details of the construction methods within [_____] days after the Notice to Proceed. The gallery shall be constructed using one of the following schemes or combination thereof, the details which shall be Contractor's responsibility:

a. Precast gallery segments,

b. Removable rigid forms against which conventional concrete, or RCC is placed, and

c. A noncementing fill as a temporary filler in the gallery area and removing it to form the gallery after the RCC has gained sufficient strength to be self-supporting.

Regardless of which procedure is used, the gallery shall be sloped to drain and shall include a gutter along the downstream gallery wall as shown in the drawings. In no case shall the gallery floor surface be allowed to pond more than 25 mm 1 inch of water. The size and shape of the gallery shall be as shown in the drawings.

[3.6.1 Precast Gallery Segments

If stay-in-place precast gallery units are used to form the gallery, they shall be constructed in accordance with [Section 03 41 33 PRECAST STRUCTURAL PRETENSIONED CONCRETE] [03 45 33 PRECAST [PRESTRESSED] STRUCTURAL CONCRETE] [_____]. The design shall be submitted for review and comment. The sections shall be designed to carry the full load of the vibratory roller over the first lift of fresh RCC above the ceiling section with a safety factor of 4 and shall be designed to carry the vibrating load of subsequent compaction without excessive deflection that could damage the previously placed RCC. For each lift, a ribbon of bedding concrete, approximately 0.09 cubic meter per linear meter 1 cubic foot per linear foot of precast panel, shall be placed between the RCC and panels. The RCC bedding concrete interface shall be thoroughly vibrated with immersion vibrators to eliminate any voids or segregation within the RCC. A permanent reinforced precast slab may be used to construct the gallery ceiling section in combination with other gallery construction schemes chosen by the contractor.

][3.6.2 Temporary Forms

The design of any temporary gallery form system and its adequacy shall be the responsibility of the Contractor. Forms shall comply with the requirements of 03 30 00 CAST-IN-PLACE CONCRETE, except that they need not be mortar-tight, and they shall meet the tolerances in paragraph CONSTRUCTION TOLERANCES in PART 1. The design of the ceiling form shall be such that it can safely carry the load of the vibratory roller with a safety factor of 4 and shall be stiff enough to prevent damage to the

fresh RCC from elastic deflection and rebound while compaction is being accomplished. The forms shall not be removed until the RCC has gained sufficient strength to be self supporting (estimated to be 90 days) and not until at least 10 m 40 feet of RCC has been placed above the gallery ceiling.

][3.6.3 Noncementing Fill Method

The gallery section may be constructed by placing a noncementitious fill in the cross-sectional area where the gallery is to be located, compacting it at the same time that the adjacent RCC is compacted, and later removing the fill. Details of how this procedure will be followed, what the noncementitious will consist of, how the fill will be removed later, and how the gallery doors will be set shall be submitted for review and comment in accordance with paragraph SUBMITTALS. To form the outline of the gallery, braced partitions (or forms) shall be placed along the perimeter of the gallery section between the RCC and non-cementitious fill. Separate partitions (or forms) shall be installed for each lift, shall be of such size and configuration, and be positioned on the previous lift's partitions (or forms) to ultimately form the gallery section. The braced partitions shall be removed during the excavation process. Alignment of partitions (or forms) shall not result in offsets and irregularities that exceed construction tolerances specified in paragraph CONSTRUCTION TOLERANCES in PART 1. The noncementitious fill material may be one or more of the standard RCC aggregates or any other approved fill material, without portland cement or pozzolan; however, nominal maximum-size aggregate shall not exceed 19.0 mm (3/4 inch). Excavation of the gallery fill shall not start until the RCC has gained sufficient strength to be self supporting (a minimum of 30 days) and until at least 10 m 35 feet of RCC has been placed above the gallery section. As soon as the strength and cover requirements have been met, removal of the gallery shall begin. The excavated fill material shall be disposed of in an approved manner.

]][3.7 SPILLWAY CONSTRUCTION

3.7.1 Spillway Chute and Ogee Section

The spillway floor shall be constructed as shown. The drawings are based on a design whereby the spillway is constructed at the same time and rate as used in placement of each RCC lift. The same technology and construction procedures as used in the construction of the vertical upstream face shall be used. The major difference being, instead of placing conventional concrete for the floor against vertical cantilevered forms, conventional concrete will be placed against sloping cantilevered forms to form the spillway chute. The design and engineering of the formwork, as well as its construction and methods of maintaining tolerances, etc., shall be the responsibility of the Contractor. The formwork shall be designed for loads, lateral pressures, and allowable stresses in accordance with Chapter 1 of ACI 347R. Forms shall be of sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances. Extreme care shall be taken to prevent the occurrence of any permanent openwork, honeycombing, or voids at the conventional concrete/RCC interface, or next to the forms. The Contractor's construction techniques shall be satisfactorily demonstrated during placement of the test section. The unformed portion of the spillway will be finished by placing concrete slightly above grade and striking off to grade by accurate screeding. The surface shall be

finished as specified in paragraph FLOAT FINISH below.

3.7.2 Training Walls

Concrete for training walls shall be as shown in the drawings and as specified in paragraph VERTICAL FACINGS FOR RCC CONSTRUCTION above.

3.7.3 Finishing

3.7.3.1 General

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 10 degrees C 50 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 1 kg/sq m 0.2 lb/sq ft per hour, provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow. All unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish, unless a trowel finish is specified, and shall be true to the elevation shown. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown in the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown or as directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions.

3.7.3.2 Float Finish

Surfaces shall be screeded and darbied or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. No water, cement, or mortar shall be added to the surface during the finishing operation. The concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, shall be floated to a true and even plane. Floating may be performed by use of suitable hand floats or power-driven equipment. Hand floats shall be made of magnesium or aluminum. Tolerance for a floated finish shall be true plane within 8 mm in 3000 mm 5/16 inch in 10 feet as determined by a 3-m 10-foot straightedge placed anywhere on the slab in any direction.

]3.8 CONSTRUCTION TOLERANCES

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NOTE: Delete any of the following tables that are not applicable. Most projects will require several tables to cover all parts of the structure.

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The definitions of the terms used in the following tables shall be as defined in ACI 117. Make level and grade tolerance measurements of slabs as soon as possible after finishing. When forms or shoring are used, the measurements shall be made prior to removal. Tolerances are not cumulative. The most restrictive tolerance controls. Tolerances shall not extend the structures beyond legal boundaries. Except as specified otherwise, plus tolerance increases the amount or dimension to which it applies or raises a level alignment, and minus tolerance decreases the amount or dimension to which it applied or lowers a level alignment. A tolerance without sign means plus or minus. Where only one signed tolerance is specified, there is no limit in the other direction.

3.8.1 Conventional Concrete Surfaces

TOLERANCES FOR CAST-IN-PLACE, VERTICALLY SLIPFORMED BUILDING ELEMENTS	
Vertical alignment Translation and rotation from a fixed point at the base of the structure:	
For heights 30 m or less	50 mm2 inches
For heights greater than 30 m, 1/600 times the height but not more than	200 mm8 inches
Lateral alignment Between adjacent elements	50 mm2 inches
Cross-sectional dimensions Wall thickness	plus 19 mm 3/4 inch minus 10 mm 3/8 inch
Relative alignment Formed surface slope with respect to the plane indicated	18 mm in 3000 mm
TOLERANCES FOR CONCRETE STRUCTURES OTHER THAN BUILDINGS	
Vertical alignment	
Visible surfaces	30 mm1-1/4 inch
Concealed surfaces	65 mm2-1/2 inches
Side walls for radial gates and similar water-tight joints	5 mm3/16 inch
Lateral alignment	
Visible surfaces	30 mm1-1/4 inch
Concealed surfaces	65 mm2-1/2 inches
Level alignment	
Visible flatwork and formed surfaces	13 mm1/2 inch
Concealed flatwork and formed surfaces	25 mm1 inch
Sills for radial gates and similar water-tight joints	5 mm3/16 inch
Relative alignment: Formed surface slope with respect to the specified plane.	
Slopes in lateral and level alignments	
Visible surfaces	6 mm in 3000 mm1/4 inch in 10 feet
Concealed surfaces	12 mm in 3000 mm1/2 inch in 10 feet
Slopes in vertical alignment	
Visible surfaces	12 mm in 3000 mm1/2 inch in 10 feet

Concealed surfaces	25 mm in 3000 mm1 inch in 10 feet
TOLERANCE FOR FINISHED OR FORMED CONVENTIONAL CONCRETE SURFACES	
Vertical alignment Formed surfaces slope with respect to the specified plane	
Vertical alignment of exposed corner columns and control joint grooves in concrete exposed to view	9 mm in 3000 mm3/8 inch in 10 feet
All other conditions	12 mm in 3000 mm1/2 inch in
Abrupt variation in spillway surface: The offset between concrete surfaces under adjacent pieces of formwork	3 mm1/8 inch
Gradual variation: Surface finish tolerances as measured by placing a freestanding (unleveled), 1500-mm or 5-ft straightedge for plane surface or curved template for curved surface anywhere on the surface and allowing it to rest upon two high spots within 72 hr after concrete placement. The gap at any point between the straightedge or template and the surface shall not exceed	6 mm1/4 inch
Offsets of adjacent precast gallery segments shall not exceed	25 mm1 inch

3.8.2 RCC Surfaces

a. Variations from the lines and grades of the gallery walls and ceiling from that shown in the drawings shall not exceed plus or minus 75 mm 3 inches except tolerances at the gallery entrances shall be kept within the limits necessary for the bulkheads and doorways to fit and function as designed.

b. Allowable variation from lines and grades of the downstream face of the dam (measured in any direction) shall be minus zero (-0) (no under build allowed) and plus 100 mm 4 inches, [except that the elevation and shape of the spillway stilling basin training walls shall be such that the training walls match with the downstream face as shown in the drawings or otherwise provided for]. See additional restrictions in paragraph DOWNSTREAM FACE in Part 3.

c. The thickness of compacted lifts of RCC shall be within plus or minus 50 mm 2 inches of that specified.

d. The elevation of the surfaces of RCC lifts upon which subsequent RCC or conventional concrete is placed shall not vary more than 150 mm 0.5 ft from the design elevation, except that the elevation of the top three lifts of the dam shall be within 60 mm 0.2 ft of that shown.

e. The location of anchor bars, waterstops, contraction joints, and drain holes shall be within 150 mm 0.5 ft of the designated locations shown.

f. The spacing of individual reinforcing steel bars in RCC shall be within 50 mm 2 inches of that shown.

g. Tolerances for exposed surfaces of upstream face concrete [, the face of the spillway chute,] and any other conventional concrete that interfaces with the RCC shall be in accordance with paragraph CONVENTIONAL CONCRETE SURFACES above.

3.9 TESTS AND INSPECTIONS

3.9.1 General

Perform the inspection and tests as described below, and based upon the results of these inspections and tests, he shall take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease. The laboratory performing the tests shall be on-site and shall conform with ASTM C1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individual who performs the inspection shall have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of [Concrete Transportation Construction Inspector (CTCI)] [Concrete Construction Inspector (CCI)], Level II. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C1077.

3.9.2 Testing and Inspection Requirements

3.9.2.1 Fine Aggregate

3.9.2.1.1 Grading

At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M, ASTM C117, and COE CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. The results shall be recorded on a sheet on which are also shown the specification limits applicable to the project.

3.9.2.1.2 Fineness-Modulus Control Chart

Results for fineness modulus shall be grouped in sets of three consecutive tests, and the average and range of each group shall be plotted on a control chart. The upper and lower control limits for average shall be drawn 0.10 units above and below the target fineness modulus, and the upper control limit for range shall be 0.20.

3.9.2.1.3 Corrective Action for Fine Aggregate Grading

When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer. Whenever a point on the fineness modulus control chart, either for average or range, is beyond one of the control limits, the frequency of testing shall be doubled. If two consecutive points are beyond the control limits, the process shall be considered out of control

and concreting shall be stopped. The Contracting Officer shall be notified, and immediate steps shall be taken to rectify the situation. After two consecutive points have fallen within the control limits, testing at the normal frequency may be resumed.

3.9.2.1.4 Moisture Content Testing

When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, there shall be at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. The times for the tests shall be selected randomly within the 8-hour period. An additional test shall be made whenever the slump is out of control or excessive variation in workability is reported by the placing foreman. When an electric moisture meter is operating satisfactorily, at least two direct measurements of moisture content shall be made per week to check the calibration of the meter. The results of tests for moisture content shall be used to adjust the added water in the control of the batch plant.

3.9.2.1.5 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more from the previous sample, the scale settings for the fine aggregate batcher and water batcher shall be adjusted (directly or by means of a moisture compensation device).

3.9.2.2 Coarse Aggregate

3.9.2.2.1 Grading

At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. When facilities are available to test samples five times as large as those required in ASTM C136/C136M, no averaging shall be done.

3.9.2.2.2 Corrective Action for Grading

When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of five tests (or two consecutive tests where large samples are used) are outside specification limits, the operation shall be considered out of control, and that fact shall be reported to the Contracting Officer, concreting shall be stopped, and immediate steps shall be taken to correct the grading.

3.9.2.2.3 Coarse Aggregate Moisture Content

A test for moisture content of each size group of coarse aggregate shall be made at least once a shift. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, frequency of

testing shall be increased to that specified previously for fine aggregate.

3.9.2.2.4 Coarse Aggregate Moisture Corrective Action

Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more from the previous sample, the scale setting for the coarse aggregate batcher and the water batcher shall be adjusted to compensate for this.

3.9.2.2.5 Material Finer than the 75 µm No. 200 Sieve

When in the opinion of the Contracting Officer, a problem exists in connection with the cleanliness of the coarse aggregate, tests shall be made in accordance with ASTM C117. Testing frequency shall be as directed.

3.9.2.2.6 Corrective Action for material finer than the 75 µm No. 200 Sieve

When material finer than the No. 200 sieve exceeds 1.0 percent of the weight of the coarse aggregate finer than 37.5 mm 1-1/2 inch or 0.5 percent of the weight of the aggregate coarser than 37.5 mm 1-1/2 inch, the Contracting Officer shall be notified, and steps, such as washing or other corrective action, shall be initiated immediately.

3.9.2.3 Quality of Aggregates

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NOTES: Tests should be those listed in paragraph QUALITY in PART 2. The petrographic examination shall be used to identify deleterious substances in aggregates. Deleterious substances shall be listed individually with respective limits.

Only a limited number of laboratories are now running ASTM C123/C123M due to the toxic chemicals required. Recommend that ASTM C295/C295M/C295M be specified.

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3.9.2.3.1 Frequency of Quality Tests

Prior to submitting samples for mixture proportioning studies, perform the tests for aggregate quality in the following list. In addition, after the start of concrete placement, perform tests for aggregate quality during concrete or aggregate production, in accordance with the following frequency schedule. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Absorption	Every 3 months	Every 3 months	ASTM C127 ASTM C128

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Flat and Elongate	Not applicable	Every 3 months	ASTM D4791
Durability Factor using Procedure A	Every 12 months	Every 12 months	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C142/C142M
Material Finer than the 75 µm No. 200 Sieve	Not applicable	Every 3 months	ASTM C117
Organic Impurities	Every 3 months	Not applicable	ASTM C40 ASTM C87/C87M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535
Liquid Limit and Plasticity Limits of -75 m No. 200 Sieve Size	Every 3 months	Not applicable	[_____]
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130
Petrographic Examination	Every 6 months	Every 6 months	[_____]
[Chert, less than 2.40 specific gravity]	Every 6 months	Every 6 months	ASTM C123/C123M
[Coal and Lignite, less than 2.00 specific gravity]	Every 6 months	Every 6 months	ASTM C123/C123M or ASTM C295/C295M

3.9.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality during submittal of samples for mixture-proportioning studies or immediately prior to start of concrete placement, production procedures or materials shall be changed and additional tests shall be performed until the material meets the quality requirements prior to proceeding with either mixture-proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, the test shall be rerun immediately. If the second test fails the quality requirement, the fact shall be reported to the Contracting Officer and immediate steps taken to rectify the situation.

3.9.2.4 Scales

3.9.2.4.1 Weighing Accuracy

The accuracy of the scales shall be checked by test weights at least once a month for conformance with the applicable requirements of paragraphs BATCH PLANT and CONTINUOUS MIXING PLANT both in PART 2. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

3.9.2.4.2 Batching and Recording Accuracy

Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. Confirm that the calibration devices described in paragraph BATCH PLANT in PART 2 for checking the accuracy of dispensed admixtures are operating properly. If a continuous mixing plant is provided, the accuracy and operation of all feeding and dispensing units shall be checked before the start of operation each day.

3.9.2.4.3 Scales Corrective Action

When the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.9.2.5 Concrete Plant Control

The measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the as-mixed aggregate and water weights per cubic meter yard for each class of concrete placed during plant operation.

3.9.2.6 Concrete

3.9.2.6.1 Conventional Concrete Slump Testing

At least two slump tests shall be made in accordance with ASTM C143/C143M on each conventional concrete mixture, including bedding mortar produced during each 8-hour period or less of concrete production each day. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. The result of each test for each mixture shall be plotted on a control chart on which the upper and lower limits are set as specified in paragraph MIXTURE PROPORTIONS AND STUDIES in PART 1. The range shall be plotted on a control chart on which the upper control limit is 50 mm 2.0 inches. Samples for slump shall be taken at the mixer, however the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between the mixer and the placement, samples shall be taken at the placement site as often as required by the Contracting

Officer.

3.9.2.6.2 Slump Corrective Action

Whenever points on the control chart approach the upper or lower control limits, an adjustment shall be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount specified in the mixture proportions provided by the Contracting Officer based on the free water available with the aggregates and that amount of water batched. If the adjustments to the batch weights of water and aggregates do not satisfactorily produce the required slump, the Contracting Officer may adjust the mixture proportions if the fine-aggregate moisture content is found to be stable and within the required limits. When a single slump is outside the control limits, such adjustment is mandatory. As soon as practical after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range above the upper control limits, the slump shall be considered to be out of control, the concreting operation halted, and the additional testing for aggregate moisture content required shall be undertaken, and action taken immediately to correct the problem.

3.9.2.6.3 Air Content

At least one test for air content of conventional concrete shall be made on a randomly selected batch of each concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Tests shall be made in accordance with ASTM C231/C231M. The average of each test for each mixture shall be plotted on control charts on which the average percent and upper and lower limits are set in accordance with paragraph MIXTURE PROPORTIONS AND STUDIES in PART 1. The range between two consecutive tests for each mixture shall be plotted on a control chart on which the upper control limits is 3.0 percent.

3.9.2.6.4 Air Content Corrective Action

Whenever points on the control chart approach the upper or lower control limits, an adjustment should be made in the amount of air-entraining admixture batched. If a single test result is outside the specification limit, immediate adjustment is mandatory. As soon as practical after each adjustment, another test shall be made to verify the correction of the adjustment. Whenever a point falls above the upper control for range, the dispenser shall be calibrated to ensure that it is operating correctly and with good reproducibility. Whenever two consecutive points either for average or range are outside the control limits, the Contracting Officer shall be notified.

3.9.2.7 Field Density

3.9.2.7.1 Testing and Checking

Density shall be determined for [each 450 square meters 5,000 square feet of completed lift] [at least eight locations per RCC lift] with a calibrated nuclear density gauge in accordance with ASTM C1040/C1040M. Densities shall be taken at depths of 100 and 200 mm 4 and 8 inches. If the densities at 100 and 200 mm 4 and 8 inches conflict, acceptance shall

be at the 200 mm 8 inch depth.

3.9.2.7.2 Action Required

Whenever the nuclear gauge indicates density less than the specified density, a retest shall be made. If the retest indicates unacceptable density, the Contracting Officer's Representative shall be notified, additional rolling shall be immediately provided, and a determination shall be made as to whether the lower density resulted from insufficient passes of the roller or a change in the mix properties. If the mix properties have changed, adjustments such as increasing or decreasing the moisture content shall be made at the batch plant. If the problem persists, the Contracting Officer may adjust the proportions of aggregates, cement, and/or pozzolan. If the lower density is the result of incomplete rolling, the operator shall be notified and the Contracting Officer may require removal of the incompletely compacted material at no cost to the Government.

3.9.2.8 Inspection Before Placing

Foundation or construction joints, forms, and embedded items shall be inspected in sufficient time prior to each concrete placement to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing. The inspection of the lift surfaces of the RCC will be a continuing activity and shall be accomplished in accordance with paragraph REGULAR LIFT-JOINT TREATMENT above.

3.9.2.9 Placing Inspection

3.9.2.9.1 Inspection

Provide full time supervision of all placing operations to insure that the correct quality of RCC, conventional concrete, or grout is placed in each location and that all other aspects of the placing operation are performed in accordance with the contract. During placing operations, the quality control staff shall measure and record concrete temperatures in accordance with ASTM C1064/C1064M, ambient temperature hourly, record weather conditions, time of placement, yardage placed, and method of placement.

3.9.2.9.2 Corrective Action

The placing foreman shall not permit placing to begin until he has verified that an adequate number of vibrators, spreaders, and compactors in working order and with competent operators are available. Placing shall not be continued if any conventional concrete is inadequately consolidated or if any lift of RCC is not fully compacted. Additional compaction, if necessary, shall be performed in accordance with paragraph ADDITIONAL COMPACTION above. If any batch of conventional concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.9.2.10 Vibrator Tests

3.9.2.10.1 Vibrator Testing and Use

The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as

directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing. In addition, the self-propelled vibratory rollers, as specified in PART 2, paragraph PRIMARY ROLLERS, shall be checked for frequency and amplitude prior to use and once every 3 months when RCC is being placed.

3.9.2.10.2 Vibrator Corrective Action

Any vibrator not meeting the requirements of paragraph VIBRATORS shall be immediately removed from service and repaired or replaced.

3.9.2.11 Curing Inspection

3.9.2.11.1 Moist Curing Inspections

At least twice each shift, and twice per day on nonwork days an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

3.9.2.11.2 Moist Curing Corrective Action

When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by one day.

3.9.2.12 Cold-Weather and Hot-Weather Protection

At least once each shift and once per day on nonwork days an inspection shall be made of all areas subject to cold-weather or hot-weather protection. Any deficiencies shall be noted, corrected, and reported.

3.9.2.13 Cold-Weather and Hot-Weather Protection Corrective Action

When a daily inspection report lists deficiencies, the deficiency shall be corrected immediately and the period of protection extended for one day.

3.9.3 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

-- End of Section --