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USACE / NAVFAC / AFCEC / NASA **UFGS-03 37 00 (November 2009)**

Preparing Activity: USACE **Superseding**
UFGS-03 37 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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SECTION 03 37 00

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11/09

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SECTION 03 37 00

PREPLACED-AGGREGATE CONCRETE
11/09

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NOTE: This guide specification covers the requirements for furnishing, hauling, and preplacing aggregate concrete incidental to the drilling and the grouting. 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).

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PART 1 GENERAL

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NOTE: The content of this specification is such that guidance given in EM 1110-2-2000, "Standard Practice for Concrete", is applicable.

****

1.1 UNIT PRICES

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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.
****

1.1.1 Payment

Payment will be made for all costs associated with unloading, handling, and storage of all aggregate, cement, [pozzolan,] fluidifier, and chemical admixture used in the work, including all costs of labor and the use of all equipment, tools, 150 by 300 mm 6 by 12 inch cylinder molds, and other materials required to complete the work, excluding cost of reinforcement and embedded parts which are specified to be paid for separately.

1.1.2 Measurement

Preplaced-Aggregate Concrete will be measured for payment based on the actual volume placed within the paylines of the structures as indicated.

1.1.3 Unit of Measure

Unit of measure: cubic meter yard.

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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2017) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal,

	Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 305R	(2010) Guide to Hot Weather Concreting

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B36.10M	(2015; Errata 2016) Welded and Seamless Wrought Steel Pipe

ASTM INTERNATIONAL (ASTM)

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 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 C142/C142M	(2017) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C150/C150M	(2020) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing 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 C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing 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 C937	(2016) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C938	(2016) Standard Practice for Proportioning Grout Mixtures for Preplaced-Aggregate Concrete
ASTM C939/C939M	(2016a) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C943	(2017) Standard Practice for Making Test Cylinders and Prisms for Determining Strength and Density of Preplaced-Aggregate Concrete in the Laboratory
ASTM C989/C989M	(2018a) Standard Specification for Slag Cement for Use in Concrete and Mortars

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 C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
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 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

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 94	(1995) Corps of Engineers Specification for Surface Retarders
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 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete

1.3 SUBMITTALS

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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

Grout Mixture Proportioning
Grout Mixer
Equipment
Vibrators
Testing and Quality Verification for Contractor Quality Control
Curing and Protection; G[, [_____]]
Cold-Weather Placing; G[, [_____]]
Hot-Weather Placing; G[, [_____]]

SD-04 Samples

Aggregates; G[, [_____]]
Cementitious Materials, Admixtures, and Curing Compound; G[, [_____]]

SD-06 Test Reports

Quality of Aggregates; G[, [_____]]
Testing and Quality Verification for Contractor Quality Control

SD-07 Certificates

Cementitious Materials
Impervious-Sheet Curing Materials
Air-Entraining Admixture
Nonshrink Grout
Grout Fluidifier
Membrane-Forming Curing Compound

1.4 QUALITY ASSURANCE

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 individuals who perform the inspection of concrete construction 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.

1.4.1 Government Preconstruction Sampling and Testing

1.4.1.1 Aggregates

****
NOTES: The Designer should consult the appropriate DM, identify the sources for aggregates, and include them in the Aggregate Sources Template attached to the end of this section. Contact the Division Laboratory for information to fill in the blanks below.
****

The aggregate sources listed at the end of this section have been tested and, at the time testing was performed, were capable of producing materials of a quality required for this project, provided suitable processing is performed. The Contractor may furnish materials from a listed source or from a source not listed. Samples from any source of coarse aggregate and any source of fine aggregate, consisting of not less than [70] [_____] kg [150] [_____] pounds of each coarse aggregate and [35] [_____] kg [75] [_____] pounds 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 and shipment of samples shall be at the Contractor's expense. [_____] days will be required to complete evaluation of the aggregates. Testing will be performed by and at the expense of the Government in accordance with COE CRD-C 114 or ASTM test methods. The cost of testing one source for each size of aggregate will be borne by the Government. If the Contractor selects more than one source for each aggregate size or selects a substitute source for any size aggregate after the original source was tested, the cost of that additional testing will be borne by the Contractor. Tests to which aggregate may be subjected are listed in paragraph QUALITY OF AGGREGATES in PART 3. The material from the proposed

source shall meet the quality requirements of this paragraph. The Government's test data and other information on aggregate quality of those sources listed at the end of this section 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 as outlined in paragraph TESTING AND QUALITY VERIFICATION FOR CONTRACTOR QUALITY CONTROL in PART 3.

1.4.1.2 Cementitious Materials, Admixtures, and Curing Compound

****
NOTE: When the optional sentence below is deleted, the corresponding manufacturer's certification should be used. EM 1110-2-2000, "Standard Practice for Concrete", provides guidance in selecting the options for Government or for Contractor testing.
****

At least 60 days in advance of concrete placement, notify the Contracting Officer of the source of materials, along with sampling location, brand name, type, and quantity to be used in the manufacture and/or curing of the concrete. [Sampling and testing will be performed by and at the expense of the Government except as otherwise specified. No material shall be used until notice has been given by the Contracting Officer that test results are satisfactory. Submit samples of materials for Government testing and approval. The Government will sample and test other chemical admixtures, curing compounds, and cementitious materials].

a. Chemical Admixtures - Chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing shall be retested at the expense of the Contractor when directed by the Contracting Officer and shall be rejected if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements in paragraph CHEMICAL ADMIXTURES in PART 2.

[b. Cement and Pozzolan - If cement or pozzolan is to be obtained from more than one source, the initial notification shall state the estimated amount to be obtained from each source and the proposed schedule of shipments.]

****
NOTE: Delete this paragraph if materials are to be accepted on the basis of a manufacturer's certification of compliance and mill test reports. See the appropriate DM or consult the Materials Engineer to select prequalified sources, (1) and (2), sealed bins, (3) and (4), or both options, (1), (2), (3), and (4). Selection of the sealed bin method, subparagraphs (3) and (4), must be fully justified in the appropriate DM.
****

[(1) Prequalified Cement Sources: Cement shall be delivered and used directly from a mill of a producer designated as a qualified source. Samples of cement for check testing will be taken at the project site or concrete-producing plant by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified cement sources is available

from Director, U.S. Army Engineer Waterways Experiment Station (USACE-WES), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.]

[(2) Prequalified Pozzolan Sources: Pozzolan shall be delivered and used directly from a producer designated as a qualified source. Samples of pozzolan for check testing will be taken at the project site by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified pozzolan sources is available from the Director, USACE-WES, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.]

[(3) Nonprequalified Cement Sources: Cement, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of testing. Sampling, testing, and the shipping inspection from the point of sampling, when the point is other than at the site of the work, will be made 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 Contractor's request and expense. When the point of sampling is other than at the site of the work, the fill gates of the sampled bin and conveyances used in shipment will be sealed under Government supervision and kept sealed until shipment from the bin has been completed. If tested cement is rehandled at transfer points, the extra cost of inspection shall be at the Contractor's expense. The cost of testing cement excess to project requirements shall also be at the expense of the Contractor. The charges for testing cement at the expense of the Contractor will be deducted from the payments due the Contractor at a rate of [_____] dollars per ton of cement represented by the tests.]

****

NOTE: To fill in the blank for cost of testing excess cement, contact the Structures Laboratory, Concrete Technology Division, WES.

****

[(4) Nonprequalified Pozzolan Sources: Pozzolan, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of certain tests. Pozzolan will also be sampled at the site when determined necessary. All sampling and testing will be 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 and 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 the above basis will be contingent on continuing compliance with the other requirements of the specifications. If a bin fails, the contents may be resampled and tested at the Contractor's expense. In this event, the pozzolan may be sampled as it is loaded into cars, trucks, or barges provided they are kept at the source until released for shipment. Unsealing and resealing of bins and sealing of shipping conveyances will be done by or under the supervision of the Government. Shipping conveyances will not be accepted at the site of the work unless received with all seals intact. If pozzolan is damaged in

shipment, handling, or storage, it shall be promptly removed from the site of the work. Pozzolan that has not been used within 6 months after testing shall be retested at the expense of the Contractor when directed by the Contracting Officer and shall be rejected if the test results are not satisfactory. If tested pozzolan is rehandled at transfer points, the extra cost of inspection shall be at the Contractor's expense. The cost of testing excess pozzolan shall be at the Contractor's expense at a rate of [_____] cents per ton of pozzolan represented by the test. The amount will be deducted from payment to the Contractor.]

1.4.2 Construction Testing by Government

The Government will sample and test aggregates, grout, and preplaced-aggregate concrete 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 placement in accordance with COE CRD-C 100. Grout will be sampled after the agitator and tested for flow in accordance with ASTM C939/C939M and air content in accordance with ASTM C231/C231M. Unconfined compressive strength test specimens will be made and cured in accordance with ASTM C943 and tested in accordance with ASTM C39/C39M.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Steel bars, welded steel wire fabric and accessories for concrete reinforcement shall comply with Section 03 30 00 CAST-IN-PLACE CONCRETE. Concrete formwork shall comply with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.1 Design of Preplaced Aggregate

****
NOTE: Consult the Structural Design Engineer and the appropriate DM to fill in the blanks.
****

Specified compressive strength shall be as follows:

COMPRESSIVE STRENGTH (MPa)	STRUCTURE OR PORTION OF STRUCTURE
34.5 MPa 5,000 psi @ [_____] days	[_____]
27.6 MPa 4,000 psi @ [_____] days	[_____]
20.7 MPa 3,000 psi @ [_____] days	[_____]
17.2 MPa 2,500 psi @ [_____] days	[_____]

2.1.2 Maximum Water-Cement Ratio (W/C)

****
NOTE: Consult EM 1110-2-2000 and the appropriate DM

to fill in the blanks and to select the appropriate W/C. When cementitious materials other than portland cement are used, see paragraph GROUT MIXTURE PROPORTIONING in PART 2 for definitions of W/C.

****

Maximum W/C shall be as follows:

WATER-CEMENT RATIO, BY MASS	STRUCTURE OR PORTION OF STRUCTURE
0.40	[_____]
0.45	[_____]
0.50	[_____]
0.55	[_____]
0.60	[_____]
0.65	[_____]

These W/Cs may cause higher strengths than required by above paragraph.

2.2 MATERIALS

2.2.1 Cementitious Materials

****

NOTE: See the appropriate DM to select the proper requirements for the Cementitious Materials Options. Other cementitious materials may be added if specifically recommended and approved in the concrete materials DM.

Delete the requirements for certificates for air-entraining admixtures, other chemical admixtures, curing compounds, portland cement, and pozzolan if the optional parts of paragraph CEMENTITIOUS MATERIALS, ADMIXTURES, AND CURING COMPOUND (above) are used.

****

Cementitious materials shall be portland cement or portland cement in combination with pozzolan [or [_____]] and shall conform to appropriate specifications listed below. No cementitious materials shall be used until notice of acceptance has been given by the Contracting Officer. Cementitious materials will be subject to check testing from samples obtained at the mill, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Material not meeting specifications shall be promptly removed from the site of work. Submit manufacturer's certification of compliance, accompanied by mill test reports attesting that materials meet the requirements of the specification under which they are furnished. Certification and mill test

reports shall be from samples taken from the particular lot furnished. Submit certificate of compliance for the following: Impervious-Sheet Curing Materials, Air-Entraining Admixture, Nonshrink Grout, Grout Fluidifier, and Membrane-Forming Curing Compound.

2.2.1.1 Portland Cement

ASTM C150/C150M, Type I or II, except that the maximum amount of tricalcium aluminate (C3A) in Type I cement shall be 15 percent [including the heat of hydration at 7 days] [including false set requirements] [low alkali when used with aggregates listed at the end of this section which require it.] [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 pozzolan or slag provided the following requirement is met. The expansion of the proposed combination when tested in accordance with ASTM C441/C441Mshall be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C150/C150M when tested in general conformance with ASTM C441/C441M. The expansion tests shall be run concurrently at an independent laboratory that is nationally recognized to perform such tests. The Government reserves the right to confirm the test results and to adjust the percentage of pozzolan or slag in the combination to suit other requirements.]

2.2.1.2 Pozzolan

Pozzolan shall conform to ASTM C618, Class [C], [F], [N], with the optional requirements for multiple factor, drying shrinkage, and uniformity [and [moderate] [severe] sulfate resistance requirements] of Table 2A. Table 1A requirement for maximum alkalis shall apply when used with aggregates listed at the end of this section to require low-alkali cement.

2.2.1.3 [Ground Granulated Blast-Furnace Slag

Ground Granulated Blast-Furnace Slag shall conform to ASTM C989/C989M, Grade [_____].]

2.2.2 Aggregates

****

NOTE: 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. 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 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 paragraph below. Delete the following paragraph if not required in the project.

****

Alkali-Silica Reactivity: 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, matching 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.

2.2.2.1 Listed Sources

****

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

****

Concrete aggregates may be furnished from any source capable of meeting the quality requirements as stated in paragraph QUALITY OF AGGREGATES in PART 3. The sources listed at the end of this section 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 listed sources are currently capable of producing aggregates that meet the required quality specified above. A Design Memorandum 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 memorandum. 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.

2.2.2.2 Fine-Aggregate Grading

The grading and uniformity of the fine aggregate shall conform to the following requirements as delivered to the grout mixer:

U. S. STANDARD SIEVE SIZE	PERCENT BY MASS, PASSING
2.36 mmNo. 8	100
1.18 mmNo. 16	95 - 100
600 µmNo. 30	55 - 80
300 µmNo. 50	30 - 55
150 µmNo. 100	10 - 30
75 µmNo. 200	0 - 10

In addition to the grading limits specified above, the fine aggregate shall have a fineness modulus of not less than 1.30 nor more than 2.10. The grading of the fine aggregate shall also be controlled so that the fineness moduli of at least four of any five consecutive test samples shall not vary more than 0.15 from the average fineness modulus of all samples previously taken.

2.2.2.3 Coarse-Aggregate Grading

The grading of the coarse aggregate shall conform to the following requirements:

PERCENT BY MASS, PASSING		
U.S. STANDARD SIEVE SIZE	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 inches
75 mm3 inches		95 - 100
50 mm2 inches	100	20 - 55
37.5 mm1-1/2 inch	95 - 100	0 - 5
25.0 mm1 inch	40 - 80	0 - 2
19.0 mm3/4 inch	20 - 45	
12.5 mm1/2 inch	0 - 5	
9.5 mm3/8 inch	0 - 2	

2.2.2.4 Coarse-Aggregate Particle Shape

The quantity of flat and elongated particles of the coarse aggregate, as defined and determined by ASTM D4791, shall not exceed 25 percent.

2.2.2.5 Concrete Aggregate Sources

****

NOTE: If an aggregate source is provided by the Government, the appropriate paragraphs from Section 03 70 00 MASS CONCRETE should be used.

****

2.2.2.5.1 List of Sources

The concrete aggregates sources may be selected from sources listed at the end of this section.

2.2.2.5.2 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 from sources not listed at the end of this section, designate only a single source or single combination of sources for aggregates. If a source for coarse or fine aggregates does not meet the quality requirements stated in paragraph QUALITY OF AGGREGATES in PART 3, the Contractor may not submit for approval other nonlisted sources but shall furnish the coarse or fine aggregate, as the case may be, from sources listed at the end of this section at no additional cost to the Government.

2.2.2.6 Coarse-Aggregate Quality

****

NOTES: 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 Chapter 2 of EM 1110-2-2000 for discussion of tests.

A list of properties and test values are unique to each project and should be taken from the concrete materials design memorandum. 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.

Depending upon the quality of aggregates available, some tests may not be required. Refer to EM 1110-2-2000 for the purpose of each test.

****

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
Durability Factor	[_____]	[_____]	COE CRD-C 114 ASTM C666/C666M
Clay Lump and Friable Particles	[_____]	[_____]	ASTM C142/C142M
Material Finer than 75-µm (No. 200) Sieve	[_____]	[_____]	ASTM C117
Organic Impurities	Not darker than No. 3 Not less than 95 percent	[_____]	ASTM C40/C40M ASTM C87/C87M
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
[Chert, Less than 2.40 specific gravity]	[_____]	[_____]	ASTM C123/C123M
[Coal and Lignite, less than 2.00 specific gravity]	[_____]	[_____]	ASTM C123/C123M

2.2.3 Chemical Admixtures

Chemical admixtures to be used, when required or permitted, shall conform to the appropriate specification listed.

2.2.3.1 Air-Entraining Admixture

The air-entraining admixture shall conform to ASTM C260/C260M.

2.2.3.2 Grout Fluidifier

Grout fluidifier shall conform to ASTM C937.

2.2.3.3 Water-Reducing or Retarding Admixtures

Water-reducing or retarding admixtures shall meet the requirements of ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.

2.2.4 Curing Materials

2.2.4.1 Impervious-Sheet Curing Materials

Impervious-sheet curing materials shall conform to ASTM C171, type optional, except polyethylene film shall not be used.

2.2.4.2 Membrane-Forming Curing Compound

Membrane-forming curing compound shall meet the requirements ofASTM C309, Type 1-D or 2, except a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted. The curing compound selected shall be compatible with any subsequent paint specified. Nonpigmented compound shall contain a fugitive dye and shall have the reflective requirements in ASTM C309 waived.

2.2.4.3 Burlap

Burlap used for curing shall conform to AASHTO M 182.

2.2.5 Water

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, or alkali, except that nonpotable water may be used if it meets the requirements of COE CRD-C 400.

2.2.6 Nonshrink Grout

Nonshrink grout shall conform to ASTM C1107/C1107M and shall be a commercial formulation suitable for the application proposed.

2.3 GROUT MIXTURE PROPORTIONING

Submit determined grout mixture proportions for review, including the quantities of all ingredients per cubic meter yard and stating the grading of the fine aggregate size that will be used in the manufacture of each quantity of concrete. The submission shall be accompanied with test reports from a laboratory complying with ASTM C1077 which show that proportions thus selected will produce preplaced-aggregate concrete of the qualities indicated. Grout mixture proportioning shall meet the following requirements:

2.3.1 Quality of Mixture

For each portion of the structure, mixture proportions shall be selected so that the strength and water-cement ratio requirements listed in paragraph DESIGN OF PREPLACED AGGREGATE in PART 1 are met. The source of materials and proportions of portland cement, [pozzolan], fluidifier, fine

aggregate, and water shall be stated. The grout proportions for the preplaced-aggregate concrete shall be determined in accordance with ASTM C938. The grout proportions for the preplaced-aggregate concrete shall meet the specified strength as determined by specimens molded in accordance with ASTM C943 and tested in accordance with ASTM C39/C39M. The maximum water-cement ratios required in paragraph MAXIMUM WATER-CEMENT RATIO (W/C) in PART 1, shall be converted to a ratio by mass of water to cement plus pozzolan or GGBF slag by mass equivalency as described in ACI 211.1. In the case where GGBF slag is used, the mass of the slag shall be included in the equations for the term P, which is used to denote the mass of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent of the total cementitious material. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the new quality of materials and concrete are satisfactory.

2.3.2 Air Content

The air content of the grout mixture as determined by ASTM C231/C231M within 15 minutes after mixing shall be 9.0 plus or minus 1.0 percent.

2.3.3 Grout Flow

The grout flow shall be 18.0 plus or minus 2.0 seconds when sampled from the agitator and tested in accordance with ASTM C939/C939M.

2.4 EQUIPMENT

Submit data on the pumping equipment and methods for pumping and delivering the grout for preplaced-aggregate concrete for review by the Contracting Officer, including the methods for transporting, handling, and depositing the coarse aggregate, the location, arrangement, and size of the pipe and inserts, sequence of pumping, method of withdrawal of injection pipe, and the rate of grout injection. Methods for venting of air from under embedded projections shall be also included.

2.4.1 Capacity

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NOTE: Refer to the appropriate DM for the capacity. Guidance is also found in EM 1110-2-2000.
****

The mixing and pumping equipment shall have a capacity of at least [_____] cubic meters yards per hour.

2.4.2 Batching Equipment

All materials shall be mechanically batched by mass except the water and admixture which may be batched by volume.

2.4.2.1 Scales

The equipment used for determining mass shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. Provide standard test reference masses and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. The tests shall be made at the frequency required in paragraph TESTING AND QUALITY

VERIFICATION FOR CONTRACTOR QUALITY CONTROL in PART 3, in the presence of a Government representative.

2.4.2.2 Batching Tolerances

2.4.2.2.1 Tolerances on Mass

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

2.4.2.2.2 Volumetric Tolerances

For volumetric batching equipment, the following tolerances shall apply to the required volume of material being batched: Water: plus or minus 1 percent. Chemical admixtures: Zero to plus 6 percent.

2.4.2.3 Grout Mixer

Provide a machine especially designed for the mixing of grout, capable of mixing grout mechanically to a uniform consistency. The mixer shall be maintained in satisfactory operating condition and kept free of hardened grout. Should any grout mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until the condition is corrected. Provide the grout mixer with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Use of revolving-drum concrete mixers will not be permitted. Submit Grout-mixer data including the make, type, and capacity of grout mixers, grout agitators, tank, pump, and pipe system proposed for producing the grout for preplaced-aggregate concrete.

2.4.2.4 Agitator Tank

The agitator tank shall have at least the same capacity as the mixer and shall be equipped to agitate the grout effectively and continuously. All grout entering the tank shall be passed through a wire sieve. The sieve size shall not be less than 4.75 mm No. 4 and not greater than 9.5 mm 3/8 inch.

2.4.2.5 Grout Pump

The grout pump shall operate by positive displacement or progressive cavity. The pump shall be equipped with a by-pass line connecting the discharge and inlet or provide circulation into the agitator for

continuous operation if line blockage or temporary shutdown of grouting operation occurs. Install a pressure gauge on the pump discharge line to indicate incipient line blockage or a plugged insert pipe. Provide standby pumping equipment.

2.4.3 Grout Pipe System

2.4.3.1 Delivery Pipes

The main delivery line carrying grout from the grout pump to the vicinity of the insert pipes shall be of such diameters that grout velocity at the planned operating rate will range between 0.6 and 1.2 meters 2 and 4 feet per second. All pipe fittings shall be watertight. Provide unions for quick disconnect to facilitate pipe cleanup when required. A manifold system, in which more than one grout insert is operative at the same time, will not be permitted.

2.4.3.2 Grout Insert Pipes

The pipes shall be [19] [25] [40] mm [3/4] [1] [1-1/2] inch in diameter conforming to ASME B36.10M Schedule 40. Standard pipe couplings may be used if the couplings are to be withdrawn not more than 4.5 m 15 feet through the preplaced aggregate. Where pipe couplings are required for greater depths of preplaced aggregate, use flush-coupled pipe conforming to ASME B36.10M Schedule 160. Connections between grout delivery hoses and insert pipes shall be by means of quick-opening fittings. Quick-disconnect pneumatic fittings will not be permitted for this purpose. All valves in the pipe system shall be plug or ball type, quick-opening, and which can be easily taken apart and cleaned. Valves over 25 mm 1 inch in diameter shall be stem lubricated.

2.4.3.3 Sounding Wells

The sounding wells shall be 50 mm 2 inch diameter steel pipe provided with milled (not burned) 13 mm 1/2-inch open slots 150 mm 6 inches long with 300 mm 12 inches between slots. The pipe shall be reamed and burrs removed before installation. The sounding line shall be equipped with a 25 mm 1 inch diameter float having a mass so as to sink in water, yet float on the grout surface within the slotted pipe.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACEMENT

3.1.1 Embedded Items

Before placement of coarse aggregate for preplaced-aggregate concrete, take care to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of grout into voids. Welding, including tack welding, will not be permitted on embedded metals within 600 mm 2 feet of the surface of the preplaced-aggregate concrete.

3.1.2 Concrete on Earth Foundations

****
NOTE: The Designer should insert the appropriate Section number and title below.
****

Earth surfaces upon which preplaced-aggregate concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of coarse aggregate, the earth foundation shall have been satisfactorily compacted in accordance with the provisions of [Section 31 00 00 EARTHWORK] [_____].

3.1.3 Concrete on Rock Foundations

Rock surfaces upon which coarse aggregate for preplaced-aggregate concrete is to be placed shall be clean, free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached, or unsound fragments. Joints in rock shall be cleaned to a satisfactory depth, as determined by the Contracting Officer, and to firm rock on the sides. Immediately before the coarse aggregate is placed, all rock surfaces shall be cleaned thoroughly by the use of air-water jets or sandblasting as defined in paragraph CONSTRUCTION JOINT TREATMENT below.

3.1.4 Underwater Placement

Coarse aggregate for underwater preplaced-aggregate concrete shall be placed on rock surfaces which are clean, free from drummy rock, coatings, debris, and loose semidetached or unsound fragments.

3.1.5 Concrete Surfaces

Concrete surfaces on which coarse aggregate is to be placed or preplaced-aggregate concrete surfaces between stages shall be clean and free from foreign material. Excessive accumulation of fine material on the surface shall be removed with high-pressure water jets or other approved methods.

3.1.6 Construction Joint Treatment

3.1.6.1 Joint Preparation

a. If grout in a preplaced-aggregate placement is not brought to the surface in order to form a construction joint, the intrusion grout rise shall stop 300 mm 12 inches below the aggregate surface. Dirt and debris shall not be allowed to collect on the aggregate surface or allowed to filter down to the grout surface. The insert pipes shall be pulled just above the grout surface before the grout stiffens and rodded clear. When pumping is ready to resume, the insert pipes shall be worked back to near contact with the hardened grout surface and then pumping slowly resumed for a few minutes.

b. Preplaced-aggregate concrete in which the grout has been brought to the surface and any other concrete surfaces to which preplaced-aggregate concrete is to be bonded shall be prepared for receiving the next lift or adjacent preplaced-aggregate concrete by cleaning with air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing

steel. Regardless of the method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean, well-bonded coarse aggregate is exposed uniformly throughout the lift surface. The edges of the coarse aggregate shall not be undercut. The surface shall be washed clean again as the last operation prior to placing the next lift.

3.1.6.2 Air-Water Cutting

Air-water cutting of a construction joint shall be performed at the proper time and only on horizontal construction joints. The air pressure used in the jet shall be 690 kPa 100 psi plus or minus 70 kPa 10 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, furnish samples of the material to be used and demonstrate the method to be used in applications. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.1.6.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 20.7 MPa 3,000 psi may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed, and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.1.6.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse-aggregate particles. The surface of the concrete shall then be washed thoroughly to remove all loose materials.

3.1.6.5 Waste Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall be subject to approval.

3.2 COARSE-AGGREGATE AND GROUT PLACEMENT

3.2.1 Coarse-Aggregate Washing and Screening

Coarse aggregate shall be washed, screened, and saturated immediately before placement. Washing of the aggregate in the forms will not be permitted. If more than one size of coarse aggregate is used, the aggregate shall be weighed, batched, and mixed in the proper proportions onto the wash screen. The wash screen may be a vibrating deck or revolving.

3.2.2 Transporting and Placing Coarse Aggregate

Coarse aggregate shall be transported to the forms and placed in substantially horizontal layers by means which will prevent objectionable segregation and breakage. Foreign material and excessive accumulation of fine material on the lift surface shall be removed before placing the next lift. Placing of coarse aggregate under water shall be continuous in each stage or lift until placement in that stage or lift is completed. When the coarse aggregate is to be placed in the dry, there shall be no vertical drop greater than 1.5 m 5 feet except where suitable equipment is provided to prevent breakage and segregation and where specifically authorized. Vehicle traffic on top of preplaced-coarse aggregate shall not be permitted.

3.2.3 Cold-Weather Placing of Preplaced-Aggregate Concrete

When the cold-weather placing of preplaced-aggregate concrete is likely to be subjected to freezing temperatures before the expiration of the curing period, concrete shall be placed in accordance with the approved procedures. Submit for approval the proposed materials, methods, and protection if preplaced-aggregate concrete is to be placed under cold-weather conditions. The ambient temperature of the space adjacent to the preplaced-aggregate concrete placement and surfaces to receive preplaced-aggregate concrete shall be above 0 degrees C 32 degrees F. The placing temperature of the preplaced aggregate concrete having a minimum dimension less than 300 mm 12 inches shall be between 13 and 24 degrees C 55 and 75 degrees F when measured in accordance with ASTM C1064/C1064M. The placing temperature of the preplaced-aggregate concrete having a minimum dimension greater than 300 mm 12 inches shall be between 10 and 21 degrees C 50 and 70 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Materials entering the grout mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals, or other materials shall not be mixed with the grout to prevent freezing. The forms shall be free of frost, and the aggregate, when deposited in the form, shall be free of ice, snow, and frozen lumps.

3.2.4 Hot-Weather Placing of Preplaced-Aggregate Concrete

****

NOTE: See the appropriate DM for the proper placing temperature.

****

Hot-weather placing of preplaced-aggregate concrete shall be properly performed and finished per the approved procedures. Submit for review and approval by the Contracting Officer the proposed materials and methods, if preplaced-aggregate concrete is to be placed under hot-weather conditions. The preplaced-aggregate concrete temperature shall not exceed [_____] degrees C F when measured in accordance with ASTM C1064/C1064M. Cooling of the mixing water may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph WATER-REDUCING OR RETARDING ADMIXTURES in PART 2, may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 49 degrees C 120 degrees F.

3.2.5 Grout Mixing and Pumping

3.2.5.1 Charging Sequence

The order of placing material in the mixer shall be as follows:

a. Water, or premixed water and fluidifier, if the fluidifier is in a liquid form.

b. Cement, or preblended cement and fluidifier, if the fluidifier is in a powder form.

c. Remaining ingredients.

3.2.5.2 Mixing Time

The mixing time for each batch, after all solids are in the mixer, shall be not less than 2 minutes. Provide the mixer with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Mixer shall not be charged in excess of the capacity recommended by the manufacturer nor shall it be operated at a speed in excess of the manufacturer's recommendation.

3.2.5.3 Pumping Procedure

Before starting to mix and pump grout, disconnect the grout hoses from inserts or from inlet points and flush the lines with water. Excess water shall be cleared from the pumps and lines. At the start of grouting, with the grout delivery lines disconnected at the inserts, grout shall be pumped and wasted until grout exiting the line is the same uniform consistency as that being discharged from the mixer. The coarse aggregate within the forms shall be in a moist condition at the time of intrusion. The intrusion shall be started at the lowest point in the aggregate. All pumping shall be done uniformly and at the rate that will permit the grout to fill all voids and avoid displacing the aggregate. After being discharged into the agitator tank, each batch of grout shall be continuously agitated until that batch is fully discharged into the pump. Grout insert pipes shall be properly arranged and spaced to ensure a relatively level uniform grout surface. Initially the outlet end of the intrusion lines shall penetrate the aggregate mass to within 50 mm 2 inches of the base of the aggregate, unless otherwise directed. The outlets shall be raised as the grout rises, and after grouting has progressed sufficiently to so permit, the outlets shall extend into the grout not less than 300 mm 12 inches. Satisfactory means shall be provided for venting the underside of embedded projections with procedures previously submitted in accordance with paragraph SUBMITTALS. Grouting shall be continued until grout of the specified quality is returned from the vent pipes, thereby indicating completeness of grout injection. During the intrusion procedure, the forms shall be externally vibrated in the vicinity of the grout surface. Sounding wells or other approved means of accurately locating the grout surface without interrupting the intrusion procedure shall be provided for observation and regulation of the level of the grout. Agitation of grout shall be continuous during any shutdown of the intrusion procedure. When there is a lapse in the operation of intrusion in excess of 15 minutes, the grout shall be recirculated through the pump, or agitator and pump. The grout delivery lines shall be flushed with clean water if they become blocked. They shall be disconnected from grout insert pipe before the flushing operation is performed and shall not be reconnected to grout insert pipe after flushing until pumping is

resumed and grout appears. In no case shall grout be used after appreciable stiffening of the grout mixture has occurred. [When placed underwater, intrusion shall begin while aggregates are being placed and shall follow closely behind aggregate placement unless otherwise approved. At no time shall the grout surface be brought closer than 300 mm 1 foot of the lowest point of the aggregate lift prior to topping out.]

3.2.5.4 Blocked Pipes

Exercise care to avoid blocking grout insert pipes by avoiding interruptions in pumping; however, when a pipe becomes blocked, it shall be withdrawn immediately until the end is at least 600 mm 2 feet above the level of the grout before an attempt is made to unblock it by washing out the line. In no case shall washing be attempted with the end of the grout line inserted in the grout.

3.2.5.5 Placing Temperature

Intrusion grout shall not be placed when the ambient temperature is below 2 degrees C 35 degrees F, unless specifically approved by the Contracting Officer. The preplaced-aggregate concrete, without special protection, shall not be subjected to freezing temperatures before grout reaches a unconfined compressive strength of 3500 kPa 500 psi. Grout which is intruded during cold weather shall have a temperature of not less than 5 degrees C 40 degrees F nor more than 15 degrees C 60 degrees F. Heating of the mixing water or fine aggregate will not be permitted until the temperature of the grout has decreased to 7 degrees C 45 degrees F. All methods and equipment for heating shall be subjected to approval.

3.3 FINISHING

****

NOTE: Consult the appropriate DM for those surfaces to receive a trowel finish, abrasive aggregate finish, or broom finish. Be sure those special finishes are shown.

****

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/square meter 0.2 psf per hour, provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material shall be made in advance of placement. 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. Additional finishing shall be as specified below and shall be true to the elevation shown in the drawings. 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 in the drawing or as directed.

3.3.1 [Formed Top Surface

A venting form constructed of muslin shall be used to produce the finished surface. The venting form shall be placed on top of the aggregate and backed up by fly screen, diamond metal lath, and sheeting boards spaced from 13 to 25 mm 1/2 to 1 inch apart. The form shall be tied down against

uplift pressure.]

3.3.2 [Screeded or Trowelled Surface

The grout shall be brought up to flood the aggregate surface and any diluted surface grout shall be removed by brooming. Following this, a thin layer of pea gravel or 9.5 to 12.5 mm 3/8 to 1/2 inch crushed aggregate shall be worked down into the surface by tamping and raking. When the surface is sufficiently hardened to permit working, the surface shall be screeded, floated, or trowelled to the specified finish.]

3.4 CURING AND PROTECTION

Submit curing medium and methods to be used, for review and approval. Curing and protection shall conform to the following requirements:

3.4.1 Duration

The length of the curing period shall be determined by the type of cementitious material, as specified below. Concrete shall be cured by an approved method.

CONCRETE CURING PERIOD	
Type I portland cement	7 days
Type II portland cement	14 days
Portland cement blended with 25 percent or less fly-ash	14 days
Portland cement blended with more than 25 percent Fly-ash	21 days

Immediately after placement, preplaced-aggregate concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, and mechanical damage. All materials and equipment needed for adequate curing and protection shall be available and at the placement site to the start of grouting. Preplaced-aggregate concrete shall be protected from the damaging effects of rain for 12 hours and from flowing water for 14 days. No fire or excessive heat, including welding, shall be permitted near or in direct contact with concrete or concrete embedments at any time.

3.4.2 Moist Curing

Preplaced-aggregate concrete that is moist-cured shall be maintained continuously, not periodically, wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, they shall be cleaned as required in paragraph APPEARANCE, below. Where wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Where steel forms are left in place during curing, the forms shall be carefully broken loose from the hardened concrete and curing water continuously applied into the void to continuously saturate the entire concrete surface. Horizontal surfaces may be moist cured by ponding, by covering with a minimum uniform thickness of 50 mm 2 inches of continuously saturated sand, or by covering

with saturated nonstaining burlap or cotton mats. Burlap and cotton mats shall be rinsed to remove soluble substances before using. Water for curing shall comply with the requirements of paragraph WATER in Part 2.

3.4.3 Curing with Membrane-Forming Curing Compound

Concrete may be cured with an approved membrane-forming curing compound in lieu of moist curing, except that membrane curing will not be permitted on any surface to which a grout-cleaned finish is to be applied or other concrete is to be bonded, on any surface containing protruding steel reinforcement, on an abrasive aggregate finish, or any surface maintained at curing temperature by use of free steam. A styrene acrylate or chlorinated rubber compound may be used for surfaces that are to be painted. The curing compound selected shall be compatible with any subsequent paint specified.

3.4.3.1 Pigmented Curing Compound

A pigmented curing compound meeting the requirements of paragraph MEMBRANE-FORMING CURING COMPOUND in PART 2, may be used on surfaces that will not be exposed to view when the project is completed.

3.4.3.2 Nonpigmented Curing Compound

A nonpigmented curing compound containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. Concrete cured with nonpigmented curing compound must be shaded from the sun for the first 3 days when the ambient temperature is 32 degrees C 90 degrees F or higher.

3.4.3.3 Application

The curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces shall be thoroughly moistened with water, and the curing compound shall be applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 520 kPa 75 psi, at a uniform coverage of not more than 10 square meters/L 400 square feet/gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause that will disrupt the continuity of the curing membrane.

3.4.4 Impervious-Sheet Curing

Horizontal surfaces may be cured using impervious sheets. The sheets shall comply with the requirements of ASTM C171, except that polyethylene film shall not be used. All surfaces shall be thoroughly wetted and be completely covered with waterproof paper, or with polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Covering shall be lapped not less than 300 mm 12 inches and securely weighted down or shall be lapped not less than 100 mm 4 inches and taped

to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Covering shall be folded down over exposed edges of the slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

3.4.5 Cold-Weather Curing and Protection

When the daily outdoor low temperature is less than 0 degrees C 32 degrees F, the temperature of the concrete shall be maintained above 5 degrees C 40 degrees F for the first 7 days after placing. In addition, during the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 15 degrees C 25 degrees F. This shall be determined by observation of ambient and concrete temperatures indicated by suitable temperatures measuring devices furnished by the Government as required and installed adjacent to the concrete surface and 50 mm 2 inches inside the surface of the concrete. The installation of the thermometers shall be made at such locations as may be directed.

3.4.6 Appearance

Permanently exposed surfaces shall be cleaned, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved.

3.5 TESTING AND QUALITY VERIFICATION FOR CONTRACTOR QUALITY CONTROL

Submit statements attesting that the concrete testing technicians and the concrete inspectors meet the specified requirements, also Contractor quality control test results and inspection reports daily and weekly as required. With the testing and quality verification, conform to the following requirements.

3.5.1 General

Perform the inspection and tests described below, and based upon the results of these inspections and tests, take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the preplaced-aggregate concreting operations are out of control, aggregate and intrusion grouting shall cease. The laboratory performing the tests shall be onsite and shall conform with ASTM C1077. 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.

3.5.2 Testing and Inspection Requirements

3.5.2.1 Fine Aggregate

3.5.2.1.1 Grading

At least once during each shift when the grout plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate. The grading shall conform to requirements in paragraph FINE-AGGREGATE GRADING in PART 2. 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.

3.5.2.1.2 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.

3.5.2.1.3 Moisture Content Testing

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 grout flow is out of control or excessive variation in consistency is reported by the placing foreman. The results of tests for moisture content shall be used to adjust the added water in the control of the grout mixing.

3.5.2.1.4 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, the scale settings for the fine-aggregate batcher and water batcher shall be adjusted (directly or by means of a moisture compensation device), if necessary to maintain the specified flow.

3.5.2.2 Coarse Aggregate

3.5.2.2.1 Gradinge

At least once during each shift in which the coarse aggregate is being placed in the forms, there shall be a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The coarse aggregates shall conform to the requirements found in paragraph COARSE-AGGREGATE GRADING in PART 2. 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 which are coarser than the specification limits for samples taken at locations other than as delivered to the forms to allow for degradation during handling.

3.5.2.2.2 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 are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Aggregate placement shall be stopped and immediate steps shall be taken to correct the grading.

3.5.2.3 Quality of Aggregates

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NOTES: Depending upon the quality of aggregates available, some tests may not be required. Refer to EM 1110-2-2000 for the purpose of each test.

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

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Submit aggregate quality test results, at least 30 days prior to start of preplaced-aggregate concrete placement. The quality of aggregates shall meet the following requirements.

3.5.2.3.1 Frequency of Quality Tests

Thirty days prior to the start of preplaced-aggregate concrete placement perform all tests for aggregate quality listed on the following page. In addition, after the start of concrete placement, perform tests for aggregate quality in accordance with the frequency schedule. Samples of fine aggregate tested after the start of concrete placement shall be taken immediately prior to entering the grout mixer. Samples of coarse aggregate tested after the start of concrete placement shall be taken immediately prior to entering the forms.

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
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	Every 3 months	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
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M
[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

3.5.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality immediately prior to start of preplaced-aggregate concreting operations, 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 preplaced-aggregate concreting operations. After preplaced-aggregate concreting operations 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.

3.5.2.4 Scales

3.5.2.4.1 Accuracy in Determination of Mass

The accuracy of the scales shall be checked by reference masses prior to start of grouting operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT in PART 2. Such tests shall also be made as directed whenever there are variations in properties of the fresh grout that could result from batching errors.

3.5.2.4.2 Scales Corrective Action

When the accuracy of determination of mass does not comply with specification requirements, grouting shall not be performed until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately to the Contracting Officer.

3.5.2.5 Grout Plant Control

The measurement of all constituent materials including cementitious materials, aggregate, water, and admixtures shall be continuously controlled. The fine aggregate mass and amount of added water shall be adjusted as necessary to compensate for free moisture in the fine aggregate. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan used, amount and source of admixtures used, aggregate source, the required aggregate and water in mass per cubic meter, amount of water as free

moisture in the fine aggregate, and the batch aggregate and mass of water per cubic meter for each mixture batched during grouting operations.

3.5.2.6 Grout Mixture

3.5.2.6.1 Air-Content Testing

Air-content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate grout mixture produced during each 8-hour period of grout production. Additional tests shall be made when excessive variation in consistency is reported by the placing foreman or Government quality assurance representative. Tests shall be made in accordance with ASTM C231/C231M. Test results shall be plotted on control charts which shall at all times be readily available to the Government. Copies of the current control charts shall be kept in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single test result reaches the upper or lower action limit, a second test shall immediately be made. The results of the two tests shall be averaged. This average shall be used as the air content of the batch to plot on the control chart for air content and on the control chart for range and to determine the need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate chart for each mixture on which an average line is set at the midpoint of the specified air-content range from paragraph AIR CONTENT in PART 2. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a control chart for range where an upper warning limit is set at 2.0 percentage points and up upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer; however, the Contractor is responsible for delivering the grout to the placement site at the stipulated flow. If the Contractor's materials or transportation methods cause flow loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer and the air content at the mixer controlled as directed.

3.5.2.6.2 Air-Content Corrective Action

Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as is practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air-content tests shall be made when grout mixing is restarted. All this shall be at no extra cost to the Government.

3.5.2.7 Test for Grout Flow

3.5.2.7.1 Tests

At least two tests shall be made on randomly selected batches of grout

mixture during each shift's production in accordance with ASTM C939/C939M. Additional tests shall be made when excessive variation in flow of grout mixture is reported by the grout foreman or Government inspector. Test results shall be plotted on control charts which shall at all times be readily available to the Government. Copies of the current control charts shall be kept in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single-flow test reaches or goes beyond the upper or lower action limit, a second test shall immediately be made on the same batch of concrete. The results of the two tests shall be averaged. This average shall be used as the flow of the batch to plot on the control chart for flow and the chart for range and to determine the need for any remedial action. An upper warning limit shall be set at 1 second below the maximum allowable flow on separate control charts for flow used for each type of mixture, and upper and lower action limit lines shall be set at the maximum and minimum allowable flows, respectively. The range between each consecutive flow test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 2 seconds. Samples for flow shall be taken at the agitator; however, the Contractor is responsible for delivering the grout to the placement site at the stipulated flow. If the Contractor's materials or transportation methods cause flow loss between mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer and the flow at the mixer controlled as directed.

3.5.2.7.2 Grout Flow Corrective Action

Whenever points on the control chart for flow reach the upper warning limit, an adjustment shall be immediately 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 allowed by the maximum W/C specified, based upon aggregates which are in a saturated surface-dry condition. When a single flow reaches the upper or lower action limit, no further grout shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive flow tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the grouting operation shall immediately be halted, and take appropriate steps to bring the flow under control. Also, additional flow tests shall be made as directed. All this shall be at no additional cost to the Government.

3.5.2.7.3 Temperature

The temperature of the grout shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C1064/C1064M. The temperature shall be reported along with the compressive strength data.

3.5.2.7.4 Compressive-Strength Specimens

At least one set of test specimens shall be made each day on each different preplaced-aggregate concrete mixture placed during the day. Additional sets of test cylinders shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A random grout sampling plan shall be developed and approved prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner.

A set of test specimens for concrete with a 28-day specified strength, in accordance with paragraph DESIGN OF PREPLACED AGGREGATE in Part 1, shall consist of six cylinders, three to be tested at 7 days and three at 28 days. A set of test specimens for concrete with a 90-day strength, in accordance with the same paragraph, shall consist of nine cylinders, three tested at 7 days, three at 28 days, and three at 90 days. Test specimens shall be molded and cured in accordance with ASTM C943 and tested in accordance with ASTM C39/C39M. All compressive-strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength tests, moving average for strength, and moving average for range for each mixture. The charts shall be similar to those found in ACI 214R.

3.5.2.8 Inspection Before Pumping Grout

Foundation or construction joints, forms, and embedded items shall be inspected for quality in sufficient time prior to each grout placement to certify to the Contracting Officer that they are ready to receive grout. The results of each inspection shall be reported in writing.

3.5.2.9 Grout Pumping

3.5.2.9.1 Placing Inspection

The placing foreman shall supervise all placing operations, shall determine that the correct quality of grout is placed in each location as directed by the Contracting Officer, and shall be responsible for measuring and recording grout temperatures and ambient temperature hourly during placing operations, weather conditions, time of grout placement, amount of grout placed, and method of placement.

3.5.2.9.2 Pumping Corrective Action

The placing foreman shall not permit grouting operations to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. If any batch of grout fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls. Submit data on the size, frequency, and amplitude of the external vibrators for review.

3.5.2.10 Curing

3.5.2.10.1 Moist-Curing Inspections

At least once each shift and once 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.

3.5.2.10.2 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 such areas shall be extended by 1 day.

3.5.2.10.3 Membrane-Curing Inspection

Do not apply curing compound until the Contractor's authorized representative has verified that the compound is properly mixed and ready for spraying. At the end of each operation, estimate the quantity of

compound used by measurement of the container and the area of concrete surface covered and compute the rate of coverage in square meters/L square feet/gallon. Note whether or not coverage is uniform.

3.5.2.10.4 Membrane-Curing Corrective Action

When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

3.5.2.10.5 Sheet-Curing Inspection

At least once each shift and once per day on nonwork days, an inspection shall be made of all areas being cured using material sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

3.5.2.10.6 Sheet-Curing Corrective Action

When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by 1 day.

3.5.2.11 Cold-Weather Protection and Sealed Insulation Curing

At least once each shift and once per day on nonwork days, an inspection shall be made of all areas subject to cold-weather protection. The protection system shall be inspected for holes, tears, unsealed joints, or other deficiencies that could result in damage to the concrete. Special attention shall be taken at edges, corners, and thin sections. Any deficiencies shall be noted, corrected, and reported.

3.5.2.12 Cold-Weather Protection Corrective Action

When a daily inspection report lists any holes, tears, unsealed joints, or other deficiencies, the deficiency shall be corrected immediately and the period of protection extended 1 day.

3.5.3 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 --