HART-MILLER ISLAND
SOUTH CELL ENVIRONMENTAL RESTORATION

TECHNICAL SPECIFICATIONS

95% SUBMISSION

May 3, 2002

Contract No. DACW51-97-D-0008

Prepared for: US Army Corps of Engineers
Baltimore District

By:

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CENAB-EN-DT (340)

JUN 10, 2002
ABBOTT/dh/24153

MEMORANDUM FOR Chief, Contracting Division

SUBJECT: Computation of Liquidated Damages for RFP DACW31-02-R-0037
HART-MILLER ISLAND SOUTH CELL RESTORATION, HART-MILLER ISLAND, MARYLAND

Estimated Construction Cost: $3,848,915
(without contingencies)

Completion Time; Calendar Days: 365

Based on the attached calculations, liquidated damages for this project will be $1,700.00 per day.

Other Costs:

FAR (Federal Acquisition Regulation) 12.201 through 12.204 gives guidance on assessment of liquidated damages. The Using Agency/Sponsor should evaluate this guidance and determine need for additional liquidated damages for this project. The current computation on this form includes minimum supervision and inspection cost as prescribed by FAR 12.203(b). If additional liquidated damages are necessary, the Using Agency/Sponsor shall show a breakdown of these costs below and attach written justification for additional costs to this liquidated damages computation form. A revised liquidate damages form will be issued including these additional cost which will become a part of the project file.

TOTAL: $1,700.00

RONALD J. MAJ, P.E.
Chief, Design Branch
Engineering Division

CENAB-OP (1180) 10 June 2002

MEMORANDUM THRU Chief, Engineering Division

FOR Chief, Computer Aided Engineering and Technical Section

SUBJECT: Liquidated Damages for FY 02 Hart-Miller Island South Cell Restoration, Hart-Miller Island, Maryland

1. The following is an estimate of the daily costs for supervision and administration of the subject dredging project:

Three Inspectors, 2 - GS-07/07, GS-07/05
Ave. hourly rate - $17.55; ave. hourly effective rate using 2.31 overhead rate - $40.55

16 hours at $40.55 per hour:	$ 648.80
8 hours at $26.33 per hour:	$ 210.64
12 hours at $ 1.76 per hour:	$ 21.12

One Construction Representative, GS-09/09
Hourly rate - $23.31; hourly effective rate using 2.31 overhead rate - $53.85

6 hours at $53.85 per hour:	$ 323.10
3 hours at $34.96 per hour:	$ 104.88

One Project Manager, GS-12/10
Hourly rate - $34.69; hourly effective rate using 2.31 overhead rate - $80.14

4 hours at $80.14 per hour:	$ 320.56
Subtotal Labor:	$ 1,629.10
Two Vehicles:	$ 60.00
Total	$ 1,689.10
Say	$ 1,700.00

2. Accordingly, liquidated damages in the amount of $1,700.00 per day should be assessed on the subject project.

RUSSELL E. MARSH
Operations Manager

MAINQUIST/CENAB-OP-TN/25674
DIX/CENAB-OP-O
MARSH/ CENAB-OP

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SECTION 02300A

EARTHWORK

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(1997) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457 mm (18-in) Drop
AASHTO T 224	(1996) Correction for Coarse Particles in the Soil Compaction Test

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1140	(1997) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(1990; R 1996el) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(1994) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 4318 (1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 MEASUREMENT

1.2.1 Excavation

The unit of measurement for excavation and borrow will be the cubic yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations. The volume to be paid for will be the number of cubic yards of material measured in its original position and removed from the excavation and borrow areas, including the excavation for ditches, gutters, and channel changes, when the material is acceptably utilized or disposed of as herein specified. The measurements will include authorized excavation of rock, authorized excavation of unsatisfactory subgrade soil, and the volume of loose, scattered rocks and boulders collected within the limits of the work; allowance will be made on the same basis for selected backfill ordered as replacement. The measurement will not include the volume of subgrade material or other material that is scarified or plowed and reused in-place, and will not include the volume excavated without authorization or the volume of any material used for purposes other than directed. The volume of overburden stripped from borrow pits and the volume of excavation for ditches to drain borrow pits, unless used as borrow material, will not be measured for payment. The measurement will not include the volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed grade.

1.3 PAYMENT

Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work.

1.3.1 Classified Excavation

Classified excavation will be paid for at the contract unit prices per cubic yard for common or rock excavation.

1.3.2 Unclassified Excavation

Unclassified excavation will be paid for at the contract unit price per cubic yard for unclassified excavation.

1.3.3 Classified Borrow

Classified borrow will be paid for at the contract unit prices per cubic yard for common or rock borrow.

1.3.4 Unclassified Borrow

Unclassified borrow will be paid for at the contract unit price per cubic yard for unclassified borrow.

1.3.5 Authorized Overhaul

Authorized overhaul will be paid for at the contract unit price per station-yard for overhaul in excess of the free-haul limit as designated in paragraph DEFINITIONS.

1.4 DEFINITIONS

1.4.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC, . Satisfactory materials for grading shall be comprised of stones less than 8 inches, except for fill material for pavements and railroads which shall be comprised of stones less than 3 inches in any dimension.

1.4.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. The Contracting Officer shall be notified of any contaminated materials.

1.4.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Testing required for classifying materials shall be in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

1.4.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve shall be expressed as a percentage of the maximum density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224. To maintain the same percentage of coarse material, the "remove and replace" procedure as described in the NOTE 8 in Paragraph 7.2 of AASHTO T 180 shall be used.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Earthwork; G.

Procedure and location for disposal of unused satisfactory material. Proposed source of borrow material.

Notification of encountering rock in the project. Advance notice on the

opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

SD-06 Test Reports

Testing; G.

Within 24 hours of conclusion of physical tests, 3 copies of test results, including calibration curves and results of calibration tests.

SD-07 Certificates

Testing; G, RE.

Qualifications of the commercial testing laboratory or Contractor's testing facilities.

1.6 SUBSURFACE DATA

Subsurface soil boring logs are shown on the drawings . The subsoil investigation report and samples of materials taken from subsurface investigations may be examined at the office of the Contracting Officer. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.7 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.7.1 Rock Excavation

Rock excavation shall include blasting, excavating, grading, and disposing of material classified as rock and shall include the satisfactory removal and disposal of boulders 1/2 cubic yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; and firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting. The removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic yard in volume that may be encountered in the work shall be included in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, such material shall be uncovered and the Contracting Officer notified by the Contractor. The Contractor shall not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

1.7.2 Common Excavation

Common excavation shall include the satisfactory removal and disposal of all materials not classified as rock excavation.

1.8 BLASTING

Blasting will not be permitted.

1.9 UTILIZATION OF EXCAVATED MATERIALS

Unsatisfactory materials removed from excavations shall be disposed of in designated waste disposal or spoil areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed of in designated areas approved for surplus material storage or designated waste areas as directed. Newly designated waste areas on Government-controlled land shall be cleared and grubbed before disposal of waste material thereon. Coarse rock from excavations shall be stockpiled and used for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. No excavated material shall be disposed of to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL EXCAVATION

The Contractor shall perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Grading shall be in conformity with the typical sections shown and the tolerances specified in paragraph FINISHING. Satisfactory excavated materials shall be transported to and placed in fill or embankment within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Such excavated material and the satisfactory material ordered as replacement shall be included in excavation. Surplus satisfactory excavated material not required for fill or embankment shall be disposed of in areas approved for surplus material storage or designated waste areas. Unsatisfactory excavated material shall be disposed of in designated waste or spoil areas. During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

3.1.1 Ditches, Gutters, and Channel Changes

Excavation of ditches, gutters, and channel changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Ditches and gutters shall not be excavated below grades shown. Excessive open ditch or gutter excavation shall be backfilled with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Material excavated shall be disposed of as shown or as directed, except that in no case shall material be deposited less than 4 feet from

the edge of a ditch. The Contractor shall maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.1.2 Drainage Structures

Excavations shall be made to the lines, grades, and elevations shown, or as directed. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm, level, stepped, or serrated surface. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, the bottom of the excavation shall not be disturbed. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

3.2 SELECTION OF BORROW MATERIAL

Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas shown on drawings . Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

3.3 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

The Contractor shall notify the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, borrow pits and other excavation areas shall be excavated providing adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.4 GRADING AREAS

Where indicated, work will be divided into grading areas within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. The Contractor shall not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing.

3.5 BACKFILL

Backfill adjacent to any and all types of structures shall be placed and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless

materials to prevent wedging action or eccentric loading upon or against the structure. Ground surface on which backfill is to be placed shall be prepared as specified in paragraph PREPARATION OF GROUND SURFACE FOR EMBANKMENTS. Compaction requirements for backfill materials shall also conform to the applicable portions of paragraphs PREPARATION OF GROUND SURFACE FOR EMBANKMENTS, EMBANKMENTS, and SUBGRADE PREPARATION, and Section 02630 STORM-DRAINAGE SYSTEM; and Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.6 PREPARATION OF GROUND SURFACE FOR EMBANKMENTS

3.6.1 General Requirements

Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; plowed, disked, or otherwise broken up to a depth of 24"; pulverized; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated as required just prior to placement of embankment materials to assure adequate bond between embankment material and the prepared ground surface.

3.6.2 Frozen Material

Embankment shall not be placed on a foundation which contains frozen material, or which has been subjected to freeze-thaw action. This prohibition encompasses all foundation types, including the natural ground, all prepared subgrades (whether in an excavation or on an embankment) and all layers of previously placed and compacted earth fill which become the foundations for successive layers of earth fill. All material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to, nights, holidays, weekends, winter shutdowns, or earthwork operations, shall be removed to a depth that is acceptable to the Contracting Officer and replaced with new material. Alternatively, the material will be thawed, dried, reworked, and recompacted to the specified criteria before additional material is placed. The Contracting Officer will determine when placement of fill shall cease due to cold weather. The Contracting Officer may elect to use average daily air temperatures, and/or physical observation of the soils for his determination. Embankment material shall not contain frozen clumps of soil, snow, or ice.

3.7 EMBANKMENTS

3.7.1 Earth Embankments

Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. The material shall be placed in successive horizontal layers of loose material not more than 8 inchesin depth. Each layer shall be spread uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, each layer shall

be plowed, disked, or otherwise broken up; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical with those requirements specified in paragraph SUBGRADE PREPARATION. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.8 SUBGRADE PREPARATION

3.8.1 Construction

Subgrade shall be shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut section shall be excavated to a depth of 6 inches below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified. The elevation of the finish subgrade shall not vary more than 0.05 foot from the established grade and cross section.

3.8.2 Compaction

Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, each layer of the embankment shall be compacted to at least 90 percent of laboratory maximum density.

3.9 FINISHING

The surface of excavations, embankments, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for graded areas shall be within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades shall be specified in paragraph SUBGRADE PREPARATION. Gutters and ditches shall be finished in a manner that will result in effective drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

3.10 TESTING

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. Field in-place density shall be determined in accordance with ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. ASTM D 2922results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the

moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017; the calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. ASTM D 2937, Drive Cylinder Method shall be used only for soft, fine-grained, cohesive soils. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements. Tests on recompacted areas shall be performed to determine conformance with specification requirements. Inspections and test results shall be certified by a registered professional civil engineer. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.10.1 Fill and Backfill Material Gradation

One test per 1,000 cubic yards stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with ASTM C 136, ASTM D 422, or ASTM D 1140.

3.10.2 In-Place Densities

a. One test per 15,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 15,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 500 linear feet, or fraction thereof, of each lift of embankment or backfill for berm.

3.10.3 Check Tests on In-Place Densities

If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 as follows:

a. One check test per lift for each 15,000 square feet, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.

b. One check test per lift for each 15,000 square feet, of fill or backfill areas compacted by hand-operated machines.

c. One check test per lift for each 500 linear feet, or fraction thereof, of embankment or backfill for berm.

3.10.4 Moisture Contents

In the stockpile, excavation, or borrow areas, a minimum of two tests per day per type of material or source of material being placed during stable weather conditions shall be performed. During unstable weather, tests shall be made as dictated by local conditions and approved by the Contracting Officer.

3.10.5 Optimum Moisture and Laboratory Maximum Density

Tests shall be made for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.10.6 Tolerance Tests for Subgrades

Continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION shall be made during construction of the subgrades.

3.11 SUBGRADE AND EMBANKMENT PROTECTION

During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. The storage or stockpiling of materials on the finished subgrade will not be permitted. No subbase, base course, ballast, or pavement shall be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.

-- End of Section --

ADDENDUM TO SECTION 02300A-EARTHWORK

SPECIAL PROVISION FOR

CONSTRUCTION OF NESTING ISLAND, HART MILLER ISLAND SOUTH CELL ENVIRONMENTAL RESTORATION

I. Nesting Island Substrate-Materials

The surface of the 0.5 acre nesting island shall be covered with a nesting substrate. The substrate shall consist of 60% pebble and/or shells and 40% clean, coarse sand. Shells shall consist of oyster shells such that 90% of the shells are between ¼ and 2 inches in size (longest dimension). Pebbles shall consist of pea gravel or other naturally occurring gravels such that 90% of the pebbles are between ¼ and 2 inches in size(longest dimension). Granite gravel shall not be acceptable. Sand, pebbles and/or shell must be thoroughly mixed prior to or during installation. The contractor must provide a sample of the nesting substrate for approval by the Contracting Officer.

II. Nesting Island Substrate-Installation

The contractor shall install 12 inches of nesting substrate across the entire surface of the 0.5 acre nesting island. The nesting substrate must be thoroughly mixed prior to or during installation. Alternatively, contractor may apply a 5 inch layer of sand and then a 7 inch layer of shell/pebbles. Contracting Officer must inspect and approve installation of nesting substrate upon completion to insure proper thickness and even distribution.

SECTION 02301N

EARTHWORK FOR STRUCTURES AND PAVEMENTS

PART 1 GENERAL

1.1 REFERENCES

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

ASPHALT INSTITUTE (AI)

AI MS-10	(1986) Soils Manual for Design of Asphalt Pavement Structures

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C33	(1997) Concrete Aggregates
ASTM C136	(1996; Rev. A) Sieve Analysis of Fine and Coarse Aggregates
ASTM D1140	(1997) Amount of Material in Soils Finer Than the No. 200 (75-Micrometer) Sieve
ASTM D1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m))
ASTM D1586	(1984; R 1992) Penetration Test and Split-Barrel Sampling of Soils
ASTM D2434	(1968; R 1994) Permeability of Granular Soils (Constant Head)
ASTM D2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D3017	(1996) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D3786	(1987) Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method
ASTM D4318	(1995; Rev. A) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D4355	(1992) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D4632	(1991; R 1996) Grab Breaking Load and Elongation of Geotextiles
ASTM D4759	(1988; R 1996) Determining the Specification Conformance of Geosynthetics
ASTM D4833	(1988; R 1996) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE EM-385-1-1	(1992) Safety and Health Requirements Manual

1.2 DEFINITIONS

1.2.1 Backfill

A specified material used in refilling a cut, trench, or other excavation, placed at a specified degree of compaction.

1.2.2 Capillary Water Barrier

A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity which is placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below a slab.

1.2.3 Cohesive Materials

Cohesive materials include materials classified by ASTM D2487 as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesive only when the fines have a plasticity index greater than zero.

1.2.4 Cohesionless Materials

Cohesionless materials include materials classified by ASTM D2487as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines have a plasticity index of zero.

1.2.5 Compaction

The process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum density obtained by the test procedure described in ASTM D1557 for general soil types.

1.2.6 Controlled Fill and Controlled Backfill

A specified soil mix or gradation of materials constructed to attain maximum bearing strength and minimize consolidation or differential

settlement under a load. Controlled fill is sometimes called "structural fill."

1.2.7 Embankment

A "fill" having a top that is higher than adjoining ground.

1.2.8 Excavation

The removal of soil, rock, or hard material to obtain a specified depth or elevation.

1.2.9 Fill

Specified material placed at a specified degree of compaction to obtain an indicated grade or elevation.

1.2.10 Hard Material

Weathered rock, dense consolidated deposits or conglomerate materials, (excluding manmade materials such as concrete) which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment with ripper teeth or the use of jack hammers for removal. Material indicated in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 between 60 and 600 blows per foot is arbitrarily defined herein as "Hard Material."

1.2.11 In Situ Soil

Existing in place soil.

1.2.12 Lift

A layer (or course) of soil placed on top of a previously prepared or placed soil.

1.2.13 Rock

Solid, homogeneous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement, exceeding 1/2 cubic yard in volume. Material indicated in the soil boring logs as having a standard penetration resistance as determined by ASTM D1586 greater than 600 blows per foot is arbitrarily defined herein as "Rock." Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.2.14 Soil

The surface material of the earth's crust resulting from the chemical and mechanical weathering of rock and organic material.

1.2.15 Subgrade

The material in excavation (cuts) and fills (embankments) immediately below any subbase, base, pavement, or other improvement. Also, as a secondary

definition, the level below which work above is referenced.

1.2.16 Topsoil

In natural or undisturbed soil formations, the fine-grained, weathered material on the surface or directly below any loose or partially decomposed organic matter. Topsoil may be a dark-colored, fine, silty, or sandy material with a high content of well decomposed organic matter, often containing traces of the parent rock material.

1.2.17 Unsatisfactory Material

Existing, in situ soil or other material which can be identified as having insufficient strength characteristics or stability to carry intended loads in fill or embankment without excessive consolidation or loss of stability. Materials classified as PT, OH, or OL by ASTM D2487 are unsatisfactory. Unsatisfactory materials also include man-made fills, refuse, frozen material, uncompacted backfills from previous construction, unsound rock or soil lenses, or other deleterious or objectionable material.

1.2.18 Working Platform

A layer of compacted crushed rock or natural stone that replaces the in situ soil to provide a stable, uniform bearing foundation for construction equipment to facilitate further site construction.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-06 Test Reports

Capillary water barrier granular fill tests

Controlled fill and Controlled backfill material tests

Topsoil tests

Fill tests

Backfill tests

Granular fill tests

SD-07 Certificates

Shoring and sheeting plan

Dewatering system

1.4 REGULATORY REQUIREMENTS

Materials and workmanship specified herein with reference to Maryland DOT-SHA Standard Specifications for Construction and Materials (1993) shall be in accordance with the referenced articles, sections and paragraphs of the standard except that contractual and payment provisions do not apply. Where the term "Engineer" is used, it shall mean the Contracting Officer. Where the term "state" is used, it shall mean "Federal Government."

1.5 DELIVERY AND STORAGE

Deliver and store materials in a manner to prevent contamination or segregation. Store synthetic fiber filter cloth to prevent exposure to direct sunlight in accordance with the manufacturer's recommendations.

1.6 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations as indicated.

b. No pipes or other man-made obstructions, except those indicated, will be encountered.

c. The character of the material to be excavated or used for subgrade is as indicated. Rock or hard material as defined in paragraph entitled "Definitions," will not be encountered.

d. Ground water elevations indicated are those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

f. Suitable backfill and fill material in the quantities required is available at the project site .

g. Blasting will not be permitted.

1.7 SITE CONDITIONS

1.7.1 Dewatering Plan

Base on site surface and subsurface conditions and available soils and hydrological data.

1.7.2 Utilities

Contact the Contracting Officer 72 hours prior to construction for the location of all existing underground utilities. Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Contact the utility companies for location(s) of their utilities. Perform work adjacent to privately owned utilities in accordance with procedures outlined by the utility company. Excavation made with power-driven equipment is not permitted within two feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work as affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

1.8 QUALITY ASSURANCE

1.8.1 Shoring and Sheeting Plan

Describe materials or shoring system to be used. Indicate whether or not any components will remain after filling or backfilling. Provide plans, sketches, or details along with calculations by a registered professional engineer. Indicate sequence and method for installation and removal.

1.8.2 Dewatering System

Describe methods to be employed in removing water from exposed surfaces and diverting surface water from other areas or structures. Describe the basic components of the dewatering system proposed and its planned method of operation. Dewatering plan, as a minimum, shall address those requirements outlined in paragraph entitled "Drainage and Dewatering."

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Soil Materials

Provide materials free from debris, roots, wood, scrap materials, vegetable matter, refuse or frozen material. Maximum particle size permitted is 3 inches. Use excavated material from the site for the work indicated when material falls within the requirements specified herein.

2.1.1.1 Controlled Fill and Controlled Backfill

Provide materials classified as GW, GP, SW, or SP, by ASTM D2487 where indicated. The liquid limit of such material shall not exceed 35 percent when tested in accordance with ASTM D4318. The plasticity index shall not be greater than 12 percent when tested in accordance with ASTM D4318, and not more than 35 percent by weight shall be finer than No. 200 sieve when tested in accordance with ASTM D1140.

2.1.1.2 General Backfill Beside Structures

Soft, spongy, highly plastic, or otherwise unstable material is prohibited. Material shall be unclassified but shall contain sufficient fines to ensure proper compaction. If more material is required than is available from on-site excavation, then provide that material from approved sources.

2.1.1.3 General Site Fill, Backfill and Embankment Material

Provide a soil material from the site that can be readily compacted to the specified densities. Materials shall be unclassified.

2.1.1.4 Working Platform

Material and thicknesses of working platform for support of construction equipment shall be at the discretion of the construction contractor. The gradation and placement of such material shall not create large void spaces upon which overlying work is indicated to be placed.

2.1.1.5 Borrow

Provide materials meeting requirements for general site fill, controlled fill and controlled backfill, general backfill, granular fill, topsoil. Obtain borrow materials in excess of those furnished from excavations described herein from borrow areas onsite.

2.2 FILTER FABRIC

Provide a pervious sheet of polyester, nylon, glass or polypropylene , ultraviolet resistant filaments woven, spun bonded, fused, or otherwise manufactured into a nonraveling fabric with uniform thickness and strength. The fabric shall have the following manufacturer certified minimum average roll properties as determined by ASTM D4759:

	Class A	Class B	
Grab tensile strength (ASTM D4632) machine and transversed direction	min.180	80	lbf
Grab elongation (ASTM D4632) machine and transverse direction	min.15	15	percent
Puncture resistance (ASTM D4833)	min. 80	25	lbf
Mullen burst strength (ASTM D3786)	min.290	130	psi
Trapezoidal tear strength (ASTM D4533)	min. 50	25	lbf
Ultraviolet Degradation (ASTM D4355)	70 Percent Strength Retained at 150 hours		

2.3 MATERIAL FOR RIP-RAP

Bedding material, Filter fabric and rock conforming to SSS-311 State Standard for construction indicated.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Shoring and Sheeting

Provide shoring and sheeting where required. In addition to Section 25 A and B of COE EM-385-1-1, and other requirements of this contract meet the following:

a. Prevent undermining of pavements, foundations and slabs.

b. Slope banks where space permits.

3.1.2 Drainage and Dewatering

Plan for and provide the structures, equipment, and construction for the collection and disposal of surface and subsurface water encountered in the course of construction.

3.1.2.1 Drainage

Dispose of surface water which may accumulate in open excavations,

unfinished fills, or other low areas. Remove water by pumping, or other methods to prevent softening of exposed surfaces. Surface dewatering plan shall include rerouting of any storm water runoff or natural drainage if necessary and shall comply with requirements specified in Section 01575N, "Temporary Environmental Controls." Collect and dispose of surface and subsurface water encountered in the course of construction.

3.1.2.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing or excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, below the working level.

Operate the dewatering system until construction work below existing water levels is complete. Measure and record the performance of the dewatering system at the same time each day by use of observation wells and piezometers installed in conjunction with the dewatering system. Have a back-up pump and system available for immediate use. See Section 01575N, "Temporary Environmental Controls" for additional requirements and 01355, "Environmental protection".

3.1.3 Protection and Restoration of Surfaces

Protect newly graded areas from traffic, erosion, and settlements. Repair and reestablish damaged or eroded slopes, elevations or grades and restore surface construction prior to acceptance. Conduct work in accordance with requirements specified in Section 01575N, "Temporary Environmental Controls."

3.1.3.1 Disposal of Excavated Material

Dispose of excavated material in such a manner that it will not obstruct the flow of runoff, streams, endanger a partly finished structure, impair the efficiency or appearance of facilities, or be detrimental to the completed work.

3.1.3.2 Stockpile Rock

Stockpile rock from on site excavations and use to construct slopes or embankments adjacent to streams, or side and bottoms of channels (rip-rap) and for protection against erosion. Remove excess stockpiled rock upon completion of construction.

3.2 SURFACE PREPARATION

3.2.1 Clearing and Grubbing

Perform as specified in Section 02231N, "Clearing and Grubbing."

3.2.2 Unsatisfactory Material

Remove organic matter, sod, muck, rubbish, and unsuitable soils under embankments which are less than 3 feet in thickness and under pavements or slabs on grade. Typical depth of removal of such unsuitable material shall be 24 inches.

3.2.2.1 Subgrade Proof Rolling

After removal of topsoil or other overburden, proof roll the existing subgrade with six passes of a minimum 15 tonpneumatic-tired roller. Operate the roller in a systematic manner to assure the number of passes over all areas, and at speeds between 2.5 and 3.5 miles per hour. When proof rolling under structures, one-half of the passes made with the roller shall be in a direction perpendicular to the other passes. Proof rolling shall be done in the presence of the Contracting Officer. Rutting or pumping shall indicate unsatisfactory material and that material shall be undercut to a depth of 24 inches, and replaced with the appropriate fill material. Perform proof rolling only when weather conditions permit. Do not proof roll wet or saturated subgrades. Materials degraded by proof rolling a wet or saturated subgrade shall be replaced by the Contractor as directed by the Contracting Officer at no cost to the Government. Notify the Contracting Officer 3 days prior to proof rolling.

3.3 EXCAVATION

Excavate to contours and dimensions indicated. Keep excavations free from water while construction is in progress. Notify the Contracting Officer immediately in writing in the event that it becomes necessary to remove rock, hard material, or other material defined as unsatisfactory to a depth greater than indicated and an adjustment in contract price will be considered in accordance with the Contract clause entitled "Differing Site Conditions." Refill excavations cut below the depths indicated with controlled fill and compact as specified herein. Excavate soil disturbed or weakened by construction operations or soils soften from exposure to weather. Refill with controlled fill and compact as specified herein.

3.3.1 Excavations for Structures and Spread Footings

Excavate to depth indicated. If excavation is deeper than indicated, then fill with controlled fill material prior to placement of footings.

3.3.2 Shoring and Sheeting

Shore and sheet excavations as described in the submitted plan, with various members sized and arranged to prevent injury to persons and damage to structures. Also arrange shoring and sheeting to preclude injurious caving during removal.

3.4 BORROW MATERIALS

Select borrow materials to meet requirements and conditions of the particular fill or backfill material to be used. Perform necessary clearing, grubbing, disposal of debris, and satisfactory drainage of borrow pits as incidental operations to the borrow excavation. Obtain borrow materials from sources off of Government property within the limits of South Cell as indicated.

3.5 FILLING AND BACKFILLING

3.5.1 Subgrade Preparation

Scarify the underlying subgrade surface to a depth of 6 inches before the fill is started. Step, bench, or break up sloped surfaces steeper than one vertical to 4 horizontal so that the fill material will bond with or be securely keyed to the existing material. Scarify existing surface to a minimum depth of 6 inches if subgrade density is less than the degree of compaction specified and recompact. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 6 inches and recompact as specified for the adjacent or overlying fill. Compact with equipment well suited to the soil being compacted. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.5.2 Fill and Backfill Beside Structures

Place required backfill material adjacent to structures and compact in a manner that prevents wedging action or eccentric loading upon or against the structures. Step or serrate slopes bounding or within areas to be backfilled to prevent sliding of the fill. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Do not place material on surfaces that are muddy, frozen, or contain frost. Do not use equipment for backfilling operations or for the formation of embankments against structures that will overload the structure. Backfilling against concrete will be done only after approval has been obtained from the Contracting Officer.

3.5.3 Controlled Fill and Controlled Backfill

Place controlled fill and controlled backfill under spread footing, concrete slabs not pile supported, and pavements in loose lifts of 8 inches. Do not place material on surfaces that are muddy, frozen, or contain frost. Compact with equipment well suited to the soil being compacted. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compact each lift as specified herein before placing the overlaying lift. Compaction shall be accomplished continuously over the entire area. Sufficient passes shall be made to ensure that specified density is obtained.

3.5.4 General Fill, and General Backfill

Construct fill, backfill and embankment at the locations and to lines and grades indicated. Use only approved materials in constructing fill on the prepared subgrade. Place satisfactory material in horizontal lifts not exceeding 8 inches in loose depth. Do not place material on surfaces that are muddy, frozen, or contain frost. Compact with equipment well suited to the soil being compacted. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compact each lift as specified before placing the overlaying lift.

3.5.5 Final Backfill for Utilities

Construct backfill (final backfill) for storm drains, manholes, utility lines, and other utility appurtenances using the material and compaction requirements specified herein for the adjacent or overlying work. Bedding and initial backfill requirements are specified in Section 02302N,

"Excavation, Backfilling, and Compacting for Utilities." Backfilling against concrete will be done only after approval has been obtained from the Contracting Officer.

3.5.6 Weather Limitations

Fill and backfill shall not be constructed when weather conditions detrimentally affect the quality of the finished course. Place fill and backfill only if the atmospheric temperature is above freezing in the shade and is rising. Do not construct fill and backfill in the rain or on saturated subgrades. If weather conditions are windy, hot or arid, with high rate of evaporation, schedule the placement in cooler portions of the day and furnish equipment to add moisture to the fill or backfill during and after placement.

3.6 SUBGRADE FILTER FABRIC

Place synthetic fiber filter fabric as indicated directly on prepared subgrade free of vegetation, stumps, rocks larger than 2 inches diameter and other debris which may puncture or otherwise damage the fabric. Repair damaged fabric by placing an additional layer of fabric to cover the damaged area a minimum of 3 feet overlap in all directions. Overlap fabric at joints a minimum of 3 feet. Obtain approval of filter fabric installation before placing fill or backfill. Place fill or backfill on fabric in the direction of overlaps and compact as specified herein. Follow manufacturer's recommended installation procedures.

3.7 BORROW

Strip the top 12 inches of soil material from designated borrow area and stockpile. After removal of the borrow material and depositing of any approved waste soil material, regrade the borrow pit using stockpiled soil materials. Shape surface to contours which provide positive drainage and which will blend in with the adjacent topography. Maximum side slopes shall be two horizontal to one vertical.

3.8 COMPACTION

Compact each layer or lift of material specified so that the in-place density tested is not less than the percentage of maximum density specified in Table III.

TABLE III

	Percent ASTM D1557 Maximum Density	
	Cohesive Material	Cohesionless Material
Fill, Embankment and Backfill		
General Fill and General Backfill under sidewalks and grassed areas	85	90
General Backfill and General Fill beside structures	90	95

TABLE III

	Percent ASTM D1557 Maximum Density	
	Cohesive Material	Cohesionless Material
Controlled fill and Controlled backfill under footings, pavements and structures	95	100
Refill undercut materials	N/A	100
Subgrade (Top of fill, backfill or cut)		
Under footings, top 12 inches	95	100
Under sidewalks, and grass areas, top 6 inches	85	90

3.9 FINISH OPERATIONS

3.9.1 Site Grading

Grade to finished grades indicated within 0.10 foot. Grade areas to drain water away from structures. Existing grades which are to remain but are disturbed by the Contractor's operations shall be restored.

3.9.2 Finishing Subgrades Under Structures and Pavements

Finish surface of top lift of fill or top of subgrade to the elevation and cross section indicated. Finished surface shall be smooth and of uniform texture. Lightly scarify or blade the finished surface to bring the finished surface to within 0.05 foot of the indicated grade and to eliminate imprints made by compaction and shaping equipment. Surface shall show no deviations in excess of 3/8 inch when tested with a 10 foot straightedge.

3.9.3 Disposition of Surplus Material

Surplus or other soil material not required or suitable for filling, backfilling, or embankment shall be wasted by disposition in the area indicated . Comply with the requirements of Section 01575N, "Temporary Environmental Controls."

3.9.4 Protection of Surfaces

Protect newly graded areas from traffic, erosion, and settlements that may occur and as required in the Section 01575N, "Temporary Environmental Controls" and as specified in the paragraph entitled "Protection and Restoration of Surfaces." Repair or reestablish damaged grades, elevations, or slopes prior to acceptance of work.

3.10 FIELD QUALITY CONTROL

3.10.1 Sampling

Furnish one 50 pound composite sample taken at random times daily being

compacted and fill material being placed. Submit samples, in the number directed, whenever the source or character of the fill, backfill, or embankment material changes. Contain each sample in a clean container and fasten to prevent loss of material. Tag each sample for identification. Tag shall contain the following information:

Contract No. _____
Sample No. _____
Date of Sample _____
Sampler _____
Source _____
Intended Use _____

3.10.2 Tests

Test fill, backfill, granular fill using ASTM C136for conformance to ASTM C33, and ASTM D2487 gradation limits. Test fill, backfill for material finer than the No. 200 sieve using ASTM D1140. Test fill, backfill for liquid limit and plasticity index using ASTM D4318. Test fill, backfill, and subgrade in cut materials for moisture density relations using ASTM D1557 . Test fill, backfill for permeability in accordance with ASTM D2434. Perform one of each of the required tests for each material used when directed. Provide additional tests as specified above for each source change. Perform density tests in randomly selected locations using ASTM D2922 and ASTM D3017 as follows: one test per 18,000 square feet in each layer of lift 500 cubic yards placed 1,000 square yards subgrade in cut. Determine moisture content of soil material in place at every location where in-place density is tested. Where ASTM D2922 and ASTM D3017 are used to test field compaction densities, verify the results of the tests by performing at least one test per day using ASTM D1556 at a location already tested by ASTM D2922 and at least one additional test using ASTM D1556 for every 10 tests performed with a nuclear device, also at locations already checked by ASTM D2922.

3.10.3 Controlled Fill

Method of in-place density tests shall be in accordance with paragraph entitled "Tests." Acceptance of the compacted material shall be determined in each location by the results of a minimum of two consecutive tests. The average of two tests shall equal or exceed the specified density. The location of the tests for each compacted layer will be randomly selected by the Contracting Officer.

3.10.4 Controlled Fill

Method of in-place density tests on the fill area by use of centerline stations beginning at Station -1+40.

3.10.4.1 Locations

The location of field density tests on the established grid for the unit of fill being tested will be selected by the Contracting Officer using a table of random numbers similar to the Asphalt Institute Publication, Appendix B, Manual Series No. 10 (AI MS-10).

3.10.4.2 Acceptance

Acceptance of the compacted materials shall be determined in each unit by the results of a series of three consecutive field in-place density tests.

Method of in-place tests shall be in accordance with paragraph "Tests." The average of three tests shall equal or exceed the specified average density requirement. Fill shall be accepted or rejected by units with a complete unit being reworked in the event of rejection. A unit shall consist of 2000 cubic yards of fill or of the total fill quantity, whichever is less and have a minimum of 2 feet of fill.

-- End of Section --

SECTION 02302N

EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D698	(1991) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft (600 kN-m/m))
ASTM D1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m))
ASTM D2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2774	(1994) Underground Installation of Thermoplastic Pressure Piping
ASTM D4254	(1991) Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE EM-385-1-1	(1996) Safety and Health Requirements Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 2	(1990) Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(1996) Flammable and Combustible Liquids Code
NFPA 70	(1999) National Electrical Code

1.2 DEFINITIONS

1.2.1 Backfill

Material used in refilling a cut, trench or other excavation.

1.2.2 Cohesive Materials

Soils classified by ASTM D2487 as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesive only when fines have a plasticity index greater than zero.

1.2.3 Cohesionless Materials

Soils classified by ASTM D2487 as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines have a plasticity index of zero.

1.2.4 Compaction

The process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum density obtained by the test procedure described in ASTM D698 or ASTM D1557 for general soil types ."

1.2.5 Granular Pipe Bedding

A dense, well-graded aggregate mixture of sand, gravel, or crushed stone (mixed individually, in combination with each other, or with suitable binder soil) placed on a subgrade to provide a suitable foundation for pipe. Granular bedding material may also consist of poorly graded sands or gravels where fast draining soil characteristics are desired.

1.2.6 In-Situ Soil

Existing in place soil.

1.2.7 Lift

A layer (or course) of soil placed on top of subgrade or a previously prepared or placed soil in a fill or backfill.

1.2.8 Refill

Material placed in excavation to correct overcut in depth.

1.2.9 Unyielding Material

Rock rib, ridge, rock protrusion, or soil with cobbles in the trench bottom requiring a covering of finer grain material or special bedding to avoid bridging in the pipe or conduit.

1.2.10 Unsatisfactory Material

In-Situ soil or other material which can be identified as having insufficient strength characteristics or stability to carry intended loads in the trench without excessive consolidation or loss of stability. Also backfill material which contains refuse, frozen material, large rocks, debris, soluble particles, and other material which could damage the pipe or cause the backfill not to compact. Materials classified as PT, OH, or OL by ASTM D2487 are unsatisfactory.

1.2.11 Unstable Material

Material in the trench bottom which lacks firmness to maintain alignment and prevent joints from separating in the pipe, conduit, or appurtenance structure during backfilling. This may be material otherwise identified as satisfactory which has been disturbed or saturated.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-06 Test Reports

Underdrainage backfill material tests

Trench backfill material tests

Pipe bedding material tests

SD-07 Certificates

Shoring and sheeting plan

Dewatering plan

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver and store materials in a manner to prevent contamination, segregation, freezing, and other damage.

1.5 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. No pipes or other man-made obstructions, except those indicated, will be encountered.

1.6 PROTECTION

1.6.1 Dewatering Plan

Base on available soil and hydrological data.

1.6.2 Utilities

Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Excavation made with power-driven equipment is not permitted within two feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility

lines or subsurface construction immediately to the Contracting Officer.

1.7 QUALITY ASSURANCE

1.7.1 Shoring and Sheeting Plan

Describe materials of shoring system to be used. Indicate whether or not components will remain after filling or backfilling. Provide plans, sketches, or details along with calculations by a professional engineer registered in any jurisdiction. Indicate sequence and method of installation and removal.

1.7.2 Dewatering Plan

Describe methods for removing collected water from open trenches and diverting surface water or piped flow away from work area.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

Provide soil materials as specified below free of debris, roots, wood, scrap material, vegetable matter, refuse, soft unsound particles, ice, or other deleterious and objectionable materials.

2.1.1 Backfill

Bring trenches to grade indicated on the drawings using material excavated on the site of this project. This material will be considered unclassified and no testing other than for compaction will be required before use as backfill.

2.1.2 Special Backfill for Structures and Pavements

Backfill trenches under roads, structures, and paved areas as specified in Section 02301N, "Earthwork for Structures and Pavements."

2.1.3 Borrow

Provide materials meeting requirement for pipe bedding and backfill.

2.1.4 Pipe Bedding

TABLE 02302-1 UTILITY EARTHWORK REFERENCES

	PIPE MATERIALS	NAVY SPECIFICATION	SOIL MATERIALS REFERENCE	INSTALLATION REF
a.	Electrical Plastic Tubing and Conduit	16302N	NEMA TC 2 NFPA 30 NFPA 70	Section 16302N
b.	Direct Burial Electrical Cables Section 16302N	16302N	NFPA 70, Article 710-3 NFPA 70, Articles 300-5 and 300-6	Section 16302N

TABLE 02302-1 UTILITY EARTHWORK REFERENCES

	PIPE MATERIALS	NAVY SPECIFICATION	SOIL MATERIALS REFERENCE	INSTALLATION REF
c.	Polyethylene (PE) Pressure Pipe	02811N 02551N	ASTM D2774, except bedding shall be SW and all material surrounding the pipe shall have maximum particle size of 1/2 inch.	ASTM D2774

2.2 BURIED WARNING AND IDENTIFICATION TAPE

Metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.

Warning Tape Color Codes

Yellow:	Electric
Blue:	Water Systems

2.2.1 Detectable Warning Tape for Non-Metallic Piping

Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Shoring and Sheeting

Provide shoring and sheeting where indicated. In addition to Section 25 A and B of COE EM-385-1-1 , include provisions in the shoring and sheeting plan that will accomplish the following:

a. Prevent undermining of pavements, foundations and slabs.

b. Prevent slippage or movement in banks or slopes adjacent to the

excavation.

3.1.2 Drainage and Dewatering

Plan for and provide the structures, equipment, and construction for the collection and disposal of surface and subsurface water encountered in the course of construction.

3.1.2.1 Drainage

Surface water shall be directed away from excavation and construction sites so as to prevent erosion and undermining of foundations. Diversion ditches, dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site and the area immediately surrounding the site and affecting operations at the site shall be continually and effectively drained.

3.1.3 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 2 feet below the working level.

Operate the dewatering system until construction work below existing water levels is complete. Have a back-up pump and system available for immediate use.

3.1.4 Underground Utilities

Location of the existing utilities (electrical line) indicated is approximate. The Contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction.

3.1.5 Structures and Surfaces

Protect newly backfilled areas and adjacent structures, slopes, or grades from traffic, erosion settlement, or any other damage. Repair and reestablish damaged or eroded grades and slopes and restore surface construction prior to acceptance.

3.2 GENERAL EXCAVATION AND TRENCHING

Keep excavations free from water while construction is in progress. Notify the Contracting Officer immediately in writing if it becomes necessary to remove rock or hard, unstable, or otherwise unsatisfactory material to a depth greater than indicated. Sloping of sides is allowed outside of roads and when less than 20 feet in depth. Make trench sides as nearly vertical as practicable except where sloping of sides is allowed. Sides of trenches shall not be sloped from the bottom of the trench up to the elevation of the top of the pipe or conduit. Excavate ledge rock, boulders, and other unyielding material to an overdepth at least 6 inches below the bottom of the pipe conduit and appurtenances unless otherwise indicated or specified.

Blasting will not be permitted. Use bedding material placed in 6 inch maximum layers to refill overdepths to the proper grade. At the Contractor's option, the excavations may be cut to an overdepth of not less than 4 inches and refilled to required grade as specified. Grade bottom of trenches accurately to provide uniform bearing and support for each section of pipe or conduit on undisturbed soil, or bedding material as indicated or specified at every point along its entire length. Trench dimensions shall be as indicated .

3.2.1 Shoring and Sheeting

Shore and sheet excavations as described in the plan submitted with various member sizes arranged to prevent injury to persons and damage to structures. Arrange shoring and sheeting to preclude injurious caving during removal. Obtain approval from the Contracting Officer prior to removing shoring, sheeting, or bracing in excavations adjacent to on-grade slabs, foundations, or other structural elements.

3.3 BEDDING

Of materials and depths as indicated for utility lines and utility line structures. Place bedding in 6 inch maximum loose lifts. Provide uniform and continuous support for each section of structure.

3.4 BURIED WARNING AND IDENTIFICATION TAPE

Install tape in accordance with manufacturer's recommendations except as modified herein. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.5 BACKFILLING

Construct backfill in two operations (initial and final) as indicated and specified in this section. Place initial backfill in 6 inch maximum loose lifts to one foot above pipe or conduit unless otherwise specified. Ensure that initially placed material is tamped firmly under pipe haunches. Bring up evenly on each side and along the full length of the pipe or conduit structure. Ensure that no damage is done to the utility or its protective coating. Place the remainder of the backfill (final backfill) in 9 inch maximum loose lifts unless otherwise specified. Compact each loose lift as specified in the paragraph entitled "General Compaction" before placing the next lift. Do not backfill in freezing weather or where the material in the trench is already frozen or is muddy, except as authorized. Where settlements greater than the tolerance allowed herein for grading occur in trenches and pits due to improper compaction, excavate to the depth necessary to rectify the problem, then backfill and compact the excavation as specified herein and restore the surface to the required elevation. Coordinate backfilling with testing of utilities. Testing for the following shall be complete before final backfilling: water distribution systems. Provide buried warning and identification tape installed in accordance with the manufacturer's recommendation.

3.6 COMPACTION

Use hand-operated, plate-type, vibratory, or other suitable hand tampers in areas not accessible to larger rollers or compactors. Avoid damaging pipes and protective pipe coatings. Compact material in accordance with the following unless otherwise specified. If necessary, alter, change, or modify selected equipment or compaction methods to meet specified

compaction requirements.

3.6.1 Compaction of Material in Subcuts or Overexcavations

In soft, weak, or wet soils, tamp refill material to consolidate to density of adjacent material in trench wall. In stable soils, compact to 90 percent of ASTM D4254 relative density.

3.6.2 Compaction of Pipe and Conduit Bedding

In soil, compact to 90 percent of ASTM D4254 relative density.

3.6.3 Compaction of Backfill

Compact initial backfill material surrounding pipes, cables, or conduits to 90 percent of ASTM D698 maximum density except where bedding and backfill are the same material. Where bedding and backfill are the same material, compact initial backfill to the density of the bedding. For utilities under structures and pavements compact succeeding layers of final backfill as specified under Section 02301N, "Earthwork for Structures and Pavements."

3.7 FINISH OPERATIONS

3.7.1 Grading

Finish to grades indicated within one-tenth of a foot. Grade areas to drain water away from structures. Grade existing grades that are to remain but have been disturbed by the Contractor's operations.

3.7.2 Disposition of Surplus Material

Surplus or other soil material not required or suitable for filling, backfilling, or grading shall be wasted by disposition within 20 feet of the work site. Spread and level wasted material.

3.7.3 Protection of Surfaces

Protect newly graded areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.8 FIELD QUALITY CONTROL

Test gravel, bedding and backfill for conformance to specified requirements. Test backfill to be used under roads and paved areas for conformance to special requirements. Test bedding and backfill for moisture-density relations in accordance with ASTM D698 as specified herein. Perform at least one of each of the required tests for each material provided. Perform sufficiently in advance of construction so as not to delay work. Provide additional tests as specified above for each change of source. Perform density and moisture tests in randomly selected locations and in accordance with ASTM D1556 as follows:

a. Bedding and backfill in trenches: One test per 250 linear feet in each lift.

b. Appurtenance structures: One test per 100 square feet or fraction thereof in each lift.

-- End of Section --

SECTION 02325N

DREDGING

PART 1 GENERAL

1.1 DEFINITION

Hard material is defined as material requiring blasting or the use of special equipment for economical removal, and includes boulders or fragments too large to be removed in one piece by the dredge.

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Submerged pipeline

Soundings or Sweepings; G

Indicate pipeline location and installation details. Submit drawings of surveys during progress of work by soundings or sweepings.

SD-07 Certificates

Protection plan

Prior to blasting, submit a plan for protection of surrounding structures, equipment, and vessels.

1.3 MATERIAL TO BE REMOVED

The material to be removed is silt and mud .

1.4 ARTIFICIAL OBSTRUCTIONS

Except as indicated, the Government has no knowledge of cables, pipes, or other artificial obstructions or of any wrecks, wreckage, or other material that would necessitate the use of explosives or the employment of additional equipment for economical removal. If actual conditions differ from those stated or shown, or both, an adjustment in contract price or time for completion, or both, will be made in accordance with "FAR 52.236-2, Differing Site Conditions."

1.5 QUANTITY OF MATERIAL

The total estimated amount of material to be removed from within the specified limits, including side slopes, but excluding overdepths, is 500 cubic yards. The maximum amount of allowable overdepth dredging is estimated to be 50 cubic yards. The estimated quantity for bidding purposes and for application of the "FAR 52.212-11, Variation in Estimated Quantity" shall be 550 cubic yards, which is the total quantity, including overdepth. The quantities listed are estimates only. Within the limits of

available funds, complete the work specified whether the quantities involved are greater or less than those estimated.

1.6 OVERDEPTH DREDGING

To cover unavoidable inaccuracies of dredging processes, material actually removed to a depth of ONE feet below the depth specified and within the dredging limits will be measured and paid for at full contract price.

1.7 SIDE SLOPES

Dredging on side slopes shall follow, as closely as practicable, the lines indicated or specified. The amount of material excavated from side slopes will be determined by either cross-sections or computer, or both.

1.8 PERMIT

The Contractor shall comply with conditions and requirements of the Corps of Engineers Permit and other State or Federal permits. The Contracting Officer will secure the permit for dredging and disposal of material as indicated. Make arrangements with the Department of the Army for disposal of excavated materials.

1.9 CHARGES

The Government will pay charges imposed for disposal of material in the disposal area.

1.10 ENVIRONMENTAL PROTECTION REQUIREMENTS

Provide and maintain during the life of the contract, environmental protective measures. Also, provide environmental protective measures required to correct conditions, such as oil spills or debris, that occur during the dredging operations. Comply with Federal, State, and local regulations pertaining to water, air, and noise pollution.

1.11 BASIS FOR BIDS

Base bids on the quantity of dredging indicated. Should the total quantity of dredging vary from that specified as the basis for bidding, the contract price will be adjusted in accordance with "FAR 52.243-4, "Changes." The dredging conditions specified and indicated describe conditions which are known. However, the Contractor is responsible for other conditions encountered which are not unusual when compared to the conditions recognized in the dredging business as usual in dredging activities such as those required under this contract.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 INSPECTION

Inspect the work, keep records of work performed, and ensure that gages, targets, ranges, and other markers are in place and usable for the intended purpose. Furnish, at the request of the Contracting Officer, boats, boatmen, laborers, and materials necessary for inspecting, supervising, and

surveying the work. When required, provide transportation for the Contracting Officer and inspectors to and from the disposal area and between the dredging plant and adjacent points on shore.

3.2 CONDUCT OF DREDGING WORK

3.2.1 Order of Work

The Contracting Officer will direct the Contractor on the order of work. The Government reserves the right to change the order of work at any time.

3.2.2 Interference with Navigation

Minimize interference with the use of channels and passages. The Contracting Officer will direct the shifting or moving of dredges or the interruption of dredging operations to accommodate the movement of vessels and floating equipment, if necessary.

3.2.2.1 Compensation for Interruption of Operations

If dredging operations are interrupted due to the movement of vessels or floating equipment, an adjustment in the contract price or time for completion, or both, will be made as provided by the contract. The Contracting Officer will notify the Contractor 7 days prior to ship movements that will affect dredging operations.

3.2.3 Lights

Each night, between sunset and sunrise and during periods of restricted visibility, provide lights for floating plants, pipelines, ranges, and markers. Also, provide lights for buoys that could endanger or obstruct navigation. When night work is in progress, maintain lights from sunset to sunrise for the observation of dredging operations. Lighting shall conform to United States Coast Guard requirements for visibility and color.

3.2.4 Ranges, Gages, and Lines

Furnish, set, and maintain ranges, buoys, and markers needed to define the work and to facilitate inspection. Establish and maintain gages in locations observable from each part of the work so that the depth may be determined. Suspend dredging when the gages or ranges cannot be seen or followed. The Contracting Officer will furnish, upon request by the Contractor, survey lines, points, and elevations necessary for the setting of ranges, gages, and buoys.

3.2.5 Plant

Maintain the plant, scows, coamings, barges, pipelines, and associated equipment to meet the requirements of the work. Promptly repair leaks or breaks along pipelines. Remove dredged material placed due to leaks and breaks.

3.2.6 Disposal of Excavated Material

Provide for safe transportation and disposal of dredged materials. Transport and dispose of dredged material in the area designated for disposal of dredged material. The deposit of dredged materials in unauthorized places is forbidden. Comply with rules and regulations of local port and harbor governing authorities.

3.2.6.1 Method of Disposal

Deposit dredged material by hopper dredge . Do not remove loaded or partially loaded scows, barges, or hopper dredges from the dredge area until the load has been measured by the Contracting Officer. Notify the Contracting Officer when scows or barges are returned to the dredge area.

3.2.6.2 Disposal in Indicated Fill Areas

In depositing excavated material for fill, uniformly grade and allow for shrinkage. Provide and maintain necessary bulkheads, dikes, ditches, weirs, spillways, and other construction necessary to confine and retain the fill in the dredge fill area.

3.2.7 Method of Communication

Provide a system of communication between the dredge crew and the crew at the disposal area. A portable two-way radio is acceptable.

3.2.8 Salvaged Material

Anchors, chains, firearms, and other articles of value, which are brought to the surface during dredging operations, shall remain or become the property of the Government and shall be deposited on shore at a convenient location near the site of the work, as directed.

3.2.9 Safety of Structures

The prosecution of work shall ensure the stability of piers, bulkheads, and other structures lying on or adjacent to the site of the work, insofar as structures may be jeopardized by dredging operations. Repair damage resulting from dredging operations, insofar as such damage may be caused by variation in locations or depth of dredging, or both, from that indicated or permitted under the contract.

3.2.10 Plant Removal

Upon completion of the work, promptly remove plant, including ranges, buoys, piles, and other markers or obstructions.

3.3 MEASUREMENT

Contractor shall take soundings before and after dredging.

3.3.1 Method of Measurement

The material removed will be measured by cubic yard in place, by means of soundings taken before and after dredging. The drawings represent existing conditions based on current available information, but will be verified and corrected, if necessary, by soundings taken before dredging in each locality. Soundings will be taken by lead line or 200 kHz sonic methods, or both, as determined by the Government; results of soundings by either or both methods will be the basis for payment. Areas sounded more than 30 days prior to dredging will be re-sounded when requested by the Contractor. The Contractor has the option of being present when such soundings are made.

3.3.2 Surveys During Progress of Work

Contract depth will be determined by soundings or sweepings taken behind the dredge as work progresses. The Contractor shall take progress soundings or sweepings.

3.3.3 Monthly Estimates

Monthly estimates of work completed will be based on the result of soundings taken during the progress of the work. Deductions will be made for dredging and disposal not in accordance with the specifications.

3.4 FINAL EXAMINATION AND ACCEPTANCE

As soon as practicable after the completion of areas, which in the opinion of the Contracting Officer, will not be affected by further dredging operations, each area will be examined by the Government by sounding or sweeping, or both. Remove shoals and lumps by dragging the bottom or by dredging. However, if the bottom is soft and the shoal areas form no material obstruction to navigation, removal may be waived at the discretion of the Contracting Officer. The Contractor will be notified when soundings or sweepings are to be made and will be permitted to accompany the sounding or sweeping party and to inspect the data and methods used in preparing the final estimate. When areas are found to be in a satisfactory condition, the work therein will be accepted as complete. Final estimates will be subject to deductions or correction of deductions previously made because of excessive overdepth, dredging outside or authorized areas, or disposal of material in an unauthorized manner.

-- End of Section --

SECTION 02370A

SOIL SURFACE EROSION CONTROL

PART 1 GENERAL

1.1 REFERENCES

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

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1995) Federal Seed Act Regulations Part 201

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) (ASTM)

ASTM D 648	(1998c) Deflection Temperature of Plastics Under Flexural Load
ASTM D 977	(1998) Emulsified Asphalt
ASTM D 1248	(1998) Polyethylene Plastics Molding and Extrusion Materials
ASTM D 1777	(1996) Thickness of Textile Materials
ASTM D 2028	(1976; R 1997) Cutback Asphalt (Rapid-Curing Type)
ASTM D 3776	(1996) Mass per Unit Area (Weight)of Fabric
ASTM D 3787	(1989) Bursted Strength of Knitted Goods: Constant-Rate-of-Traverse (CRT), Ball Burst Test
ASTM D 3884	(1992) Test Method for Abrasion Resistance of Textile Fabrics (Rotary Platform, Double Head Method)
ASTM D 4355	(1992) Deterioration of Geotextiles From Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1999) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoidal Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 1996) Grab Breaking Load and Elongation of Geotextiles

ASTM D 4751	(1999) Determining Apparent Opening Size of a Geotextile
ASTM D 4833	(1998; R 1996el) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4972	(1995a) pH of Soils
ASTM D 5268	(1996) Topsoil Used for Landscaping Purposes

1.2 DESCRIPTION OF WORK

The work shall consist of furnishing and installing soil surface erosion control materials, including fine grading, blanketing, stapling, mulching and miscellaneous related work, within project limits and in areas outside the project limits where the soil surface is disturbed from work under this contract at the designated locations. This work shall include all necessary materials, labor, supervision and equipment for installation of a complete system. This section shall be coordinated with the requirements of Section 02300 EARTHWORK and Section 02921 SEEDING, .

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout; G
Obstructions Below Ground; G, RE
Erosion Control; G, RE

Scale drawings defining areas to receive recommended materials as required by federal, state or local regulations.

Seed Establishment Period; G, RE

Calendar time period for the seed establishment period. When there is more than one seed establishment period, the boundaries of the seeded area covered for each period shall be described.

Maintenance Record; G, RE

Record of maintenance work performed, of measurements and findings for product failure, recommendations for repair, and products replaced.

SD-03 Product Data

Geotextile Fabrics; G, RE

Manufacturer's literature including physical characteristics, application and installation instructions.

Equipment; G, RE

A listing of equipment to be used for the application of erosion control materials.

Erosion Control Blankets; G, RE

Condition of finish grade status prior to installation; location of underground utilities and facilities.

SD-04 Samples

Materials; G, RE

b. Standard mulch; 2 pounds.

d. Geotextile fabrics; 6 inch square.

e. Erosion control blankets; 6 inch square.

SD-06 Test Reports

Geotextile Fabrics; G, RE
Erosion Control Blankets; G, RE

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

Sand; G, RE

Sieve test results. Sand shall be uniformly graded.

SD-07 Certificates

Mulch; G, RE

Geotextile Fabrics; G, RE

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

For items listed in this section:

a. Certification of recycled content or,

b. Statement of recycled content.

c. Certification of origin including the name, address and telephone number of manufacturer.

Certification for binders showing EPA registered uses, toxicity levels, and application hazards.

Erosion Control Plan; G, RE
Construction Work Sequence Schedule; G, RE

Erosion control plan. Construction sequence schedule.

Installer's Qualification; G, RE

The installer's company name and address; training and experience and or certification.

Recycled Plastic; G, RE

Individual component and assembled unit structural integrity test; creep tolerance; deflection tolerance; and vertical load test results. The estimated percentage of recovered material content in the material and components. Life-cycle durability.

Seed; G, Re

Classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.

Asphalt Adhesive; G, Re

Composition.

Wood By-Products; G, RE

Composition, source, and particle size. Products shall be free from toxic chemicals or hazardous material.

Wood; G, RE

Certification stating that wood components were obtained from managed forests.

SD-10 Operation and Maintenance Data

Maintenance Instructions; G, Re

Instruction for year-round care of installed material. The Contractor shall include manufacturer supplied spare parts.

1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

Materials shall be stored in designated areas and as recommended by the manufacturer protected from the elements, direct exposure, and damage. Containers shall not be dropped from trucks. Material shall be free of defects that would void required performance or warranty. Geosynthetic binders and synthetic soil binders shall be delivered in the manufacturer's original sealed containers and stored in a secure area.

a. Erosion control blankets and geotextile fabric shall be furnished in rolls with suitable wrapping to protect against moisture and extended ultraviolet exposure prior to placement. Erosion control blanket and geotextile fabric rolls shall be labeled to provide identification sufficient for inventory and quality control purposes.

c. Seed shall be inspected upon arrival at the jobsite for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, shall be rejected.

1.5 SUBSTITUTIONS

Substitutions will not be allowed without written request and approval from the Contracting Officer.

1.6 INSTALLER'S QUALIFICATION

The installer shall be certified by the manufacturer for training and experience installing the material.

1.7 TIME LIMITATIONS

Backfilling the openings in synthetic grid systems and articulating cellular concrete block systems shall be completed a maximum 7 days after placement to protect the material from ultraviolet radiation.

1.8 WARRANTY

Erosion control material shall have a warranty for use and durable condition for project specific installations. Temporary erosion control materials shall carry a minimum eighteen month warranty. Permanent erosion control materials shall carry a minimum three year warranty.

PART 2 PRODUCTS

2.1 RECYCLED PLASTIC

Recycled plastic shall contain a minimum 85 percent of recycled post-consumer product. Recycled material shall be constructed or manufactured with a maximum 1/4 inch deflection or creep in any member, according to ASTM D 648 and ASTM D 1248. The components shall be molded of ultraviolet (UV) and color stabilized polyethylene. The material shall consist of a minimum 75 percent plastic profile of high-density polyethylene, low-density polyethylene, and polypropylene raw material. The material shall be non-toxic and have no discernible contaminates such as paper, foil, or wood. The material shall contain a maximum 3 percent air voids and shall be free of splinters, chips, peels, buckling, and cracks. Material shall be resistant to deformation from solar heat gain.

2.2 BINDERS

2.2.1 Synthetic Soil Binders

Calcium chloride, or other standard manufacturer's spray on adhesives designed for dust suppression.

2.3 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region.

2.3.1 Straw

Straw shall be stalks from oats, wheat, rye, barley, or rice, furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment.

2.3.2 Hay

Hay shall be native hay, sudan-grass hay, broomsedge hay, or other herbaceous mowings, furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment.

2.3.3 Wood Cellulose Fiber

Wood cellulose fiber shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to facilitate placement during application. Composition on air-dry weight basis: a minimum 9 to a maximum 15 percent moisture, and between a minimum 4.5 to a maximum 6.0 pH.

2.3.4 Paper Fiber

Paper fiber mulch shall be recycled news print that is shredded for the purpose of mulching seed.

2.3.5 Shredded Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

2.3.6 Wood Chips and Ground Bark

Locally chipped or ground material shall be treated to retard the growth of mold and fungi. Gradation: A maximum 2 inch wide by 4 inch long.

2.3.7 Asphalt Adhesive

Asphalt adhesive shall conform to the following: Emulsified asphalt, conforming to ASTM D 977, Grade SS-1; and cutback asphalt, conforming to ASTM D 2028, Designation RC-70.

2.3.8 Mulch Control Netting

Mulch control netting may be constructed of lightweight recycled plastic, cotton, or paper or organic fiber. The recycled plastic shall be a woven or nonwoven polypropylene, nylon, or polyester containing stabilizers and/or inhibitors to make the fabric resistant to deterioration from UV, and with the following properties:

a. Minimum grab tensile strength (TF 25 #1/ASTM D 4632), 180 pounds.

b. Minimum Puncture (TF 25 #4/ASTM D 3787), 75 psi in the weakest direction.

c. Apparent opening sieve size of a minimum 40 and maximum 80 (U.S. Sieve Size)..

d. Minimum Trapezoidal tear strength (TF 25 #2/ASTM D 4533), 50 pounds.

2.4 GEOTEXTILE FABRICS

Geotextile fabrics shall be woven of polypropylene filaments formed into a stable network so that the filaments retain their relative position to each other. Sewn seams shall have strength equal to or greater than the geotextile itself. Fabric shall be installed to withstand maximum velocity flows as recommended by the manufacturer. The geotextile shall conform to the following minimum average roll values:

Property	Performance	Test Method
Weight		ASTM D 3776
Thickness		ASTM D 1777
Permeability		ASTM D 4491
Abrasion Resistance, Type (percent strength retained)	58 percent X 81 percent	ASTM D 3884
Tensile Grab Strength	1,467 N X 1, 933 N	ASTM D 4632
Grab Elongation	15percent X 20percent	ASTM D 4632
Burst Strength	5,510 kN/m^2	ASTM D 3787
Puncture Strength	733 N	ASTM D 4833
Trapezoid Tear	533 N X 533 N	ASTM D 4533
Apparent Opening Size	40 US Std Sieve	ASTM D 4751
UV Resistance @ 500 hrs	90 percent	ASTM D 4355

2.5 EROSION CONTROL BLANKETS

2.5.1 Erosion Control Blankets Type I

Type I blankets shall be used for erosion control and vegetation establishment on roadside embankments, abutments, berms, shoulders, and median swales where natural vegetation will provide long term stabilization. Erosion control blankets shall be a machine-produced mat of 100% straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with a photodegradable polypropylene netting having an approximate 1/2 by 1/2 inch mesh and be sewn together on a maximum 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately ..50 lb/yd^2 weight
Netting	One side only, lightweight photodegradable with approximately 1.64 lb/1,000 ft^2 weight.
Thread	Degradable

Note 1: Photodegradable life a minimum of 2 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 3:1 gradient.

2.5.2 Seed

2.5.2.1 Seed Classification

State-approved seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS Seed Act and applicable state seed laws.

2.5.2.2 Quality

Weed seed shall be a maximum 1 percent by weight of the total mixture.

2.5.3 Staking

Stakes shall be 100 percent biodegradable manufactured from recycled plastic or wood and shall be designed to safely and effectively secure erosion control blankets for temporary or permanent applications. The biodegradable stake shall be fully degradable by biological activity within a reasonable time frame. The bio-plastic resin used in production of the biodegradable stake shall consist of polylactide, a natural, completely biodegradable substance derived from renewable agricultural resources. The biodegradable stake must exhibit ample rigidity to enable being driven into hard ground, with sufficient flexibility to resist shattering. The biodegradable stake shall have serrations on the leg to increase resistance to pull-out from the soil.

2.5.4 Staples

Staples shall be as recommended by the manufacturer.

2.6 WATER

Unless otherwise directed, water shall be the responsibility of the Contractor. Water shall be potable or supplied by an existing irrigation system.

PART 3 EXECUTION

3.1 CONDITIONS

The Contractor shall submit a construction work sequence schedule, with the approved erosion control plan a minimum of 30 days prior to start of construction. The work schedule shall coordinate the timing of land disturbing activities with the provision of erosion control measures. Erosion control operations shall be performed under favorable weather conditions; when excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped as directed. When special conditions warrant a variance to earthwork operations, a revised construction schedule shall be submitted for approval. Erosion control materials shall not be applied in adverse weather conditions which could affect their performance.

3.1.1 Finished Grade

The Contractor shall verify that finished grades are as indicated on the drawings; finish grading and compaction shall be completed in accordance with Section 02300 "Earthwork", prior to the commencement of the work. The

location of underground utilities and facilities in the area of the work shall be verified and marked. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

3.1.2 Placement of Erosion Control Blankets

Before placing the erosion control blankets, ensure the subgrade has been graded smooth; has no depressed, void areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter. Vehicles shall not be permitted directly on the blankets.

3.2 SITE PREPARATION

3.2.1 Soil Test

Soil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size and mechanical analysis. Sample collection onsite shall be random over the entire site. The test shall determine the soil particle size as compatible for the specified material.

3.2.2 Layout

Erosion control material locations may be adjusted to meet field conditions. When soil tests result in unacceptable particle sizes, a shop drawing shall be submitted indicating the corrective measures.

3.2.3 Protecting Existing Vegetation

When there are established lawns in the work area, the turf shall be covered and/or protected or replaced after construction operations. Existing trees, shrubs, and plant beds that are to be preserved shall be barricaded along the dripline. Damage to existing trees shall be mitigated by the Contractor at no additional cost to the Government. Damage shall be assessed by a state certified arborist or other approved professional using the National Arborist Association's tree valuation guideline.

3.2.4 Obstructions Below Ground

When obstructions below ground affect the work, shop drawings showing proposed adjustments to placement of erosion control material shall be submitted for approval.

3.3 INSTALLATION

3.3.1 Seeding

When seeding is required prior to installing mulch on synthetic grid systems the Contractor shall verify that seeding will be completed in accordance with Sections 02300 "Earthwork" and 02921 "Seeding".

3.3.2 Mulch Installation

Mulch shall be installed in the areas indicated. Mulch shall be applied evenly at the rate of 8 ounces per square yard.

3.3.3 Mulch Control Netting

Netting may be stapled over mulch according to manufacturer's recommendations.

3.3.4 Mechanical Anchor

Mechanical anchor shall be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.3.5 Asphalt Adhesive Coated Mulch

Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 10 to 13 gallons per 1000 square feet, using power mulch equipment which shall be equipped with suitable asphalt pump and nozzle. The adhesive-coated mulch shall be applied evenly over the surface. Sunlight shall not be completely excluded from penetrating to the ground surface.

3.3.6 Wood Cellulose Fiber, Paper Fiber, and Recycled Paper

Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydraulic mulch operation.

3.3.7 Erosion Control Blankets

a. Erosion control blankets shall be installed as indicated and in accordance with manufacturer's recommendations. The extent of erosion control blankets shall be as shown on drawings.

b. Erosion control blankets shall be oriented in vertical strips and anchored with staples, as indicated. Adjacent strips shall be abutted to allow for installation of a common row of staples. Horizontal joints between erosion control blankets shall be overlapped sufficiently to accommodate a common row of staples with the uphill end on top.

c. Where exposed to overland sheet flow, a trench shall be located at the uphill termination. The erosion control blanket shall be stapled to the bottom of the trench. Backfill and compact the trench as required.

d. Where terminating in a channel containing an installed blanket, the erosion control blanket shall overlap installed blanket sufficiently to accommodate a common row of staples.

3.4 CLEAN-UP

Excess material, debris, and waste materials shall be disposed on-site at an approved area.

3.5 WATERING SEED

Watering shall be started immediately after installing erosion control blanket type XI (revegetation mat). Water shall be applied to supplement rainfall at a sufficient rate to ensure moist soil conditions to a minimum 1 inch depth. Run-off and puddling shall be prevented. Watering trucks shall not be driven over turf areas, unless otherwise directed. Watering of other adjacent areas or plant material shall be prevented.

3.6 MAINTENANCE RECORD

A record shall be furnished describing the maintenance work performed, record of measurements and findings for product failure, recommendations for repair, and products replaced.

3.6.1 Maintenance

Maintenance shall include eradicating weeds; protecting embankments and ditches from surface erosion; maintaining the performance of the erosion control materials and mulch; protecting installed areas from traffic.

3.6.1.1 Maintenance Instructions

Written instructions containing drawings and other necessary information shall be furnished, describing the care of the installed material; including, when and where maintenance should occur, and the procedures for material replacement.

3.6.1.2 Patching and Replacement

Unless otherwise directed, material shall be placed, seamed or patched as recommended by the manufacturer. Material not meeting the required performance as a result of placement, seaming or patching shall be removed from the site. The Contractor shall replace the unacceptable material at no additional cost to the Government.

-- End of Document --

SECTION 02510N

WATER DISTRIBUTION

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2774	(1994) Underground Installation of Thermoplastic Pressure Piping

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C508	(1993) Swing-Check Valves for Waterworks Service, 2 in. (50 mm) Through 24 in. (600 mm) NPS
AWWA C509	(1994) Resilient-Seated Gate Valves for Water and Sewerage Systems
AWWA C550	(1990) Protective Epoxy Interior Coating for Valves and Hydrants
AWWA C600	(1993) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C906	(1990) Polyethylene (PE) Pressure Pipe and Fittings, 4 in. Through 63 in., for Water Distribution

1.2 DESIGN REQUIREMENTS

1.2.1 Water Distribution Mains

Provide water distribution mains indicated as 8, 10, 12, and 14 inch lines of High Density Polyethylene (HDPE) pipe containing a minimum of 2.0% carbon black finely divided and evenly dispersed for UV protection. Provide water main accessories, gate valves and check valves as specified and where indicated. Submit design calculations of water piping.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-03 Product Data

Piping Materials

Water distribution main piping, fittings, joints, valves, and

coupling

Valve boxes

Sprinkler Heads

Submit manufacturer's standard drawings or catalog cuts. Submit both drawings and cuts for heat fusion joints and/or mechanical connections, including HDPE to metal flange backup connections.

SD-05 Design Data

Design calculations of water piping

SD-07 Certificates

Water distribution main piping, fittings, joints, valves, and coupling

Sprinkler Heads

Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

SD-08 Manufacturer's Instructions

Installation procedures for water piping

The manufacturer of pipe, tubing and fittings supplied under this specification shall establish and qualify heat fusion procedures for the joining of the materials supplied. Qualified fusion procedures, with appropriate supporting data, shall be furnished to the Contracting Officer.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves and sprinkler heads free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, valves, sprinkler heads, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry, do not drag pipe to the trench. Store jointing materials and rubber gaskets that are not to be installed immediately, under cover out of direct

sunlight.

PART 2 PRODUCTS

2.1 WATER DISTRIBUTION MAIN MATERIALS

2.1.1 Piping Materials

Pipe, tubing and fittings shall be homogeneous throughout, and free of visible cracks, holes, foreign inclusions, blisters, dents, or other injurious defects. The pipe, tubing, and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

2.1.1.1 Polyethylene (PE) Plastic Piping

Pipe and heat-fusion fittings shall conform to AWWA C906.

Polyethylene compounds utilized in the manufacture of products furnished under this specification shall have a grade of PE24 with a minimum cell classification of PE234343(C, D, or E) for PE2406 materials, as defined in ASTM D3350.

Butt fusion fittings shall comply with ASTM D3261.

The pipe and fittings shall have a dimension ratio (DR) equal to or less than 9.3 and a working pressure rating (WPR) of 150 psi or greater at 73 degrees F.

Non-polyethylene fittings shall be specified and used in accordance with the surge tolerance of the particular appurtenance in use.

2.1.2 Valves, Hydrants, and Other Water Main Accessories

2.1.2.1 Gate Valves

AWWA C509. Unless otherwise specified, valves conforming to AWWA C509 shall be nonrising stem type with mechanical-joint ends. Valves shall open by counterclockwise rotation of the valve stem. Stuffing boxes shall have 0-ring stem seals. Stuffing boxes shall be bolted and constructed so as to permit easy removal of parts for repair. Valves shall be of one manufacturer. Valves shall have a protective epoxy interior coating conforming to AWWA C550. Bronze used in valves shall be Grade A, Grade D, or Grade E as specified in AWWA C509 for water main gate valves.

2.1.2.2 Check Valves

Swing-check type, AWWA C508. Valves conforming to AWWA C508 shall have iron or steel body and cover and flanged ends. Valves shall be of one manufacturer. Valves shall have a protective epoxy interior coating conforming to AWWA C550. Bronze used in valves shall be Grade A, Grade D, or Grade E as specified in AWWA C508 for water main check valves.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

3.1.1 General Requirements for Installation of Pipelines

These requirements shall apply to all pipeline installation except where specific exception is made in the "Special Requirements..." paragraphs.

3.1.1.1 Location of Water Lines

Do not lay water lines in the same trench with electric wiring.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 02302, "Excavation, Backfilling, and Compacting for Utilities."

3.1.1.3 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or any other water line material into trenches. Cut pipe accurately to length established at the site and work into place without springing or forcing. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at proper elevation and grade. Secure firm, uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding of the ground surface; excavate recesses to accommodate joints and couplings. Provide anchors and supports where indicated and where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been properly made. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation.

3.1.2 Special Requirements for Installation of Water Mains

3.1.2.1 Installation of Polyethylene (PE) Plastic Piping

PE pipes shall be installed in accordance with ASTM D 2774.

3.1.2.2 Installation of Valves and Sprinkler Heads

a. Installation of Valves: Install gate valves, AWWA C509, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509. Install check valves in accordance with the applicable requirements of AWWA C600 for valve-and-fitting installation. Make and assemble joints to gate valves and check valves.

b. Installation of Sprinkler Heads: Install sprinkler heads in accordance with manufacturer's recommendation and as indicated. Make and assemble joints using a polyethylene flange adaptor as shown on the drawings. Provide metal harness as specified under pipe anchorage requirements for the respective pipeline material to which sprinkler head is attached.

3.1.2.3 Marking

Pipe and tubing shall be marked in accordance with AWWA C906. Marking shall be legible and shall remain legible under normal handling and installation practices. Indent marking may be utilized provided (1) the marking does not reduce the wall thickness to less than the minimum value for the pipe or tubing, (2) it has been demonstrated that these marks have no effect on the long term strength of the pipe or tubing and (3) the marks do not provide leakage channels when elastomeric gasket compression fitting are used to make the joints.

Fittings shall be marked on the body or hub. Marking shall be in accordance with either ASTM D3261 or AWWA C906 depending on fitting type and the standard that applies. Mechanical fittings shall be marked with size, body material designation code, pressure rating and manufacturer's name or trademark.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications. Do not begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least 5 days after placing of the concrete.

3.2.2 Testing Procedure

Test water mains in accordance with the applicable specified standard, except for the special testing requirements given in paragraph entitled "Special Testing Requirements." No leakage will be allowed at plastic pipe joints.

3.2.3 Special Testing Requirements

For pressure test, use a hydrostatic pressure 50 psi greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger than 2 inches in diameter, hydrostatic test pressure shall be not less than 200 psi. Hold this pressure for not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

-- End of Section --

SECTION 02630A

STORM-DRAINAGE SYSTEM

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 198	(1998) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	(1994a) Gray Iron Castings
ASTM A 536	(1999el) Ductile Iron Castings
ASTM B 26/B 26M	(1998) Aluminum-Alloy Sand Castings
ASTM C 231	(1997el) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(1997) Mortar for Unit Masonry
ASTM C 425	(1998b) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1998) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 877	(1994) External Sealing Bands for Noncircular Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 923	(1998) Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Materials
ASTM C 1103	(1994) Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM D 1056	(1998) Flexible Cellular Materials - Sponge or Expanded Rubber

ASTM D 1171	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996el) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2321	(1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(1998a) Polyethylene Plastics Pipe and Fittings Materials
ASTM F 894	(1998a) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Placing Pipe; G

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

SD-04 Samples

Pipe for Culverts and Storm Drains; G

Samples of the following materials, before work is started: G.

SD-07 Certificates

Resin Certification; G, RE
Pipeline Testing; G, RE
Hydrostatic Test on Watertight Joints; G, RE
Determination of Density; G, RE
Frame and Cover for Gratings; G, RE

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 PE Pipe

The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

2.1.1.1 Profile Wall PE Pipe

ASTM F 894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 334433C. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment Of Inertia of Wall Section (in to the 4th/in) Cell Class 334433C	Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

2.2 MISCELLANEOUS MATERIALS

2.2.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 3500 psi concrete under Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

2.2.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 2 gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.2.3 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478. Joints

between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure.

2.2.4 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26/B 26M, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

2.2.5 Joints

2.2.5.1 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877.

2.2.5.2 Flexible Watertight, Gasketed Joints

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D 1056, Type 2, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

2.2.5.3 Profile Wall PE Plastic Pipe

Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F 894.

2.3 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes shall conform to ASTM C 923.

2.4 HYDROSTATIC TEST ON WATERTIGHT JOINTS

2.4.1 Concrete, Clay, PVC and PE Pipe

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample

joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C 443. Test requirements for joints in clay pipe shall conform to ASTM C 425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D 3212.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 02316 "Excavation, Trenching, and Backfilling for Utilities Systems"d and the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 18 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements.

Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

3.4 JOINTING

3.4.1 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.5 DRAINAGE STRUCTURES

3.5.1 Manholes

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

3.5.2 Walls and Headwalls

Construction shall be as indicated.

3.6 BACKFILLING

3.6.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 6 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.6.2 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.6.3 Compaction

3.6.3.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.6.4 Determination of Density

Testing shall be the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017 or ASTM D 2922. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each

different type of material encountered and at intervals as directed.

3.7 PIPELINE TESTING

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C 1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 250 gallons per inch in diameter per mile of pipeline per day . When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correcting, and retesting shall be made at no additional cost to the Government.

-- End of Section --

SECTION 02731A

AGGREGATE SURFACE COURSE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1557	(1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2922	(1996el) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1996el) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(1999c) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4318	(1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

1.2 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated herein as present laboratory maximum density.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment; G

List of proposed equipment to be used in performance of construction work including descriptive data.

SD-06 Test Reports

Sampling and Testing; G, RE
Density Tests; G, RE

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Test results from samples, not less than 30 days before material is required for the work. Results of laboratory tests for quality control purposes, for approval, prior to using the material.

1.4 EQUIPMENT

All plant, equipment, and tools used in the performance of the work covered by this section will be subject to approval by the Contracting Officer before the work is started and shall be maintained in satisfactory working condition at all times. The equipment shall be adequate and shall have the capability of producing the required compaction, and meeting the grade controls, thickness controls, and smoothness requirements set forth herein.

1.5 SAMPLING AND TESTING

Sampling and testing shall be the responsibility of the Contractor. Sampling and testing shall be performed by an approved commercial testing laboratory or by the Contractor, subject to approval. If the Contractor elects to establish its own testing facilities, approval of such facilities will be based on compliance with ASTM D 3740. No work requiring testing will be permitted until the Contractor's facilities have been inspected and approved.

1.5.1 Sampling

Sampling for material gradation, liquid limit, and plastic limit tests shall be taken in conformance with ASTM D 75. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.5.2 Testing

1.5.2.1 Gradation

Aggregate gradation shall be made in conformance with ASTM C 117, ASTM C 136, and ASTM D 422. Sieves shall conform to ASTM E 11.

1.5.2.2 Liquid Limit and Plasticity Index

Liquid limit and plasticity index shall be determined in accordance with ASTM D 4318.

1.5.3 Approval of Materials

The source of the material to be used for producing aggregates shall be selected 30 days prior to the time the material will be required in the work. Approval of sources not already approved by the Corps of Engineers will be based on an inspection by the Contracting Officer. Tentative approval of materials will be based on appropriate test results on the aggregate source. Final approval of the materials will be based on tests for gradation, liquid limit, and plasticity index performed on samples taken from the completed and compacted surface course.

1.6 WEATHER LIMITATIONS

Aggregate surface courses shall not be constructed when the ambient temperatures is below 35 degrees F and on subgrades that are frozen or contain frost. It shall be the responsibility of the Contractor to protect, by approved method or methods, all areas of surfacing that have not been accepted by the Contracting Officer. Surfaces damaged by freeze, rainfall, or other weather conditions shall be brought to a satisfactory condition by the Contractor.

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall consist of clean, sound, durable particles of natural gravel, crushed gravel, crushed stone, sand, slag, soil, or other approved materials processed and blended or naturally combined. Aggregates shall be free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign materials. The Contractor shall be responsible for obtaining materials that meet the specification and can be used to meet the grade and smoothness requirements specified herein after all compaction and proof rolling operations have been completed.

2.1.1 Coarse Aggregates

The material retained on the No. 4 sieve shall be known as coarse aggregate. Coarse aggregates shall be reasonably uniform in density and quality. The coarse aggregate shall have a percentage of wear not to exceed 50 percent after 500 revolutions as determined by ASTM C 131. The amount of flat and/or elongated particles shall not exceed 20 percent. A flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the requirements set forth herein.

2.1.2 Fine Aggregates

The material passing the No. 4 sieve shall be known as fine aggregate.

Fine aggregate shall consist of screenings, sand, soil, or other finely divided mineral matter that is processed or naturally combined with the coarse aggregate.

2.1.3 Gradation Requirements

Gradation requirements specified in TABLE I shall apply to the completed aggregate surface. It shall be the responsibility of the Contractor to obtain materials that will meet the gradation requirements after mixing, placing, compacting, and other operations. TABLE I shows permissible gradings for granular material used in aggregate surface roads and airfields. Sieves shall conform to ASTM E 11.

TABLE I. GRADATION FOR AGGREGATE SURFACE COURSES

Sieve Designation	No. 1	No. 2	No. 3	No. 4
1 in.	100	100	100	100
3/8 in.	50-85	60-100	--	--
No. 4	35-65	50-85	55-100	70-100
No. 10	25-50	40-70	40-100	55-100
No. 40	15-30	24-45	20-50	30-70
No. 200	8-15	8-15	8-15	8-15

2.2 LIQUID LIMIT AND PLASTICITY INDEX REQUIREMENTS

The portion of the completed aggregate surface course passing the No. 40 sieve shall have a maximum liquid limit of 35 and a plasticity index of 4.

PART 3 EXECUTION

3.1 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating shall be the responsibility of the Contractor. The aggregate sources shall be operated to produce the quantity and quality of materials meeting these specification requirements in the specified time limit. Upon completion of the work, the aggregate sources on Government property shall be conditioned to drain readily and be left in a satisfactory condition. Aggregate sources on private lands shall be conditioned in agreement with local laws or authorities.

3.2 STOCKPILING MATERIALS

Prior to stockpiling the material, the storage sites shall be cleared and leveled by the Contractor. All materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at the locations designated. Aggregates shall be stockpiled in such a manner that will prevent segregation. Aggregates and binders obtained from different sources shall be stockpiled separately.

3.3 PREPARATION OF UNDERLYING COURSE SUBGRADE

The subgrade, including shoulders, shall be cleaned of all foreign substances. At the time of surface course construction, the subgrade shall contain no frozen material. Ruts or soft yielding spots in the subgrade areas having inadequate compaction and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing

soft or unsatisfactory material and by adding approved material, reshaping to line and grade and recompacting to density requirements specified in Section 02721 SUBBASE COURSES. The completed subgrade shall not be disturbed by traffic or other operations and shall be maintained by the Contractor in a satisfactory condition until the surface course is placed.

3.4 GRADE CONTROL

During construction, the lines and grades including crown and cross slope indicated for the aggregate surface course shall be maintained by means of line and grade stakes placed by the Contractor in accordance with the SPECIAL CONTRACT REQUIREMENTS.

3.5 MIXING AND PLACING MATERIALS

The materials shall be mixed and placed to obtain uniformity of the material and a uniform optimum water content for compaction. The Contractor shall make adjustments in mixing, placing procedures, or in equipment to obtain the true grades, to minimize segregation and degradation, to obtain the desired water content, and to ensure a satisfactory surface course.

3.6 LAYER THICKNESS

The aggregate material shall be placed on the subgrade in layers of uniform thickness. When a compacted layer of 6 inches or less is specified, the material may be placed in a single layer; when a compacted thickness of more than 6 inches is required, no layer shall exceed 6 inches nor be less than 3 inches when compacted.

3.7 COMPACTION

Each layer of the aggregate surface course shall be compacted with approval compaction equipment. The water content during the compaction procedure shall be maintained at optimum or at the percentage specified by the Contracting Officer. In locations not accessible to the rollers, the mixture shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to at least 100 percent of laboratory maximum density. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked to produce a satisfactory material.

3.8 PROOF ROLLING

Proof rolling of the areas designated shall be in addition to compaction specified above and shall consist of application of 30 coverages with a heavy rubber-tired roller having four tires abreast with each tire loaded to 30,000 pounds and tires inflated to 150 psi. In the areas designated, proof rolling shall be applied to the top lift of layer on which surface course is laid and to each layer of the base course. Water content of the lift of the layer on which the surface course is placed and each layer of the aggregate surface course shall be maintained at optimum or at the percentage directed from the start of compaction to the completion of a proof rolling. Materials in the aggregate surface course or underlying materials indicated unacceptable by the proof rolling shall be removed and replaced, as directed, with acceptable materials.

3.9 EDGES OF AGGREGATE-SURFACED ROAD

Approved material shall be placed along the edges of the aggregate surface course in such quantity as to compact to the thickness of the course being constructed. When the course is being constructed in two or more layers, at least 1 foot of shoulder width shall be rolled and compacted simultaneously with the rolling and compacting of each layer of the surface course.

3.10 SMOOTHNESS TEST

The surface of each layer shall not show any deviations in excess of 3/8 inch when tested with a 10 foot straightedge applied both parallel with and at right angles to the centerline of the area to be paved. Deviations exceeding this amount shall be corrected by the Contractor by removing material, replacing with new material, or reworking existing material and compacting, as directed.

3.11 THICKNESS CONTROL

The completed thickness of the aggregate surface course shall be within 1/2 inch, plus or minus, of the thickness indicated on plans. The thickness of the aggregate surface course shall be measured at intervals in such manner that there will be a thickness measurement for at least each 500 square yards of the aggregate surface course. The thickness measurement shall be made by test holes at least 3 inches in diameter through the aggregate surface course. When the measured thickness of the aggregate surface course is more than 1/2 inch deficient in thickness, the Contractor, at no additional expense to the Government, shall correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting, as directed. Where the measured thickness of the aggregate surface course is more than 1/2 inch) thicker than that indicated, it shall be considered as conforming with the specified thickness requirements plus 1/2 inch. The average job thickness shall be the average of the job measurements determined as specified above, but shall be within 1/4 inch of the thickness indicated. When the average job thickness fails to meet this criterion, the Contractor shall, at no additional expense to the Government, make corrections by scarifying, adding or removing mixture of proper gradation, and reblading and recompacting, as directed.

3.12 DENSITY TESTS

Density shall be measured in the field in accordance with ASTM D 2922. For the method presented in ASTM D 2922 the calibration curves shall be checked and adjusted, if necessary, using only the sand cone method as described in paragraph Calibration of the ASTM publication. Tests performed in accordance with ASTM D 2922 result in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration of ASTM D 2922, on each different type of material being tested at the beginning of a job and at intervals, as directed.

3.13 WEAR TEST

Wear tests shall be made in conformance with ASTM C 131.

3.14 MAINTENANCE

The aggregate surface course shall be maintained in a condition that will meet all specification requirements until accepted.

-- End of Section --

SECTION 02741N

BITUMINOUS CONCRETE PAVEMENT

PART 1 GENERAL

1.1 REFERENCES

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 T30	(1993) Mechanical Analysis of Extracted of Aggregate
AASHTO T230	(1968; R 1993) Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2950	(1991) Density of Bituminous Concrete in Place by Nuclear Methods

STATE OF MARYLAND HIGHWAY SPECIFICATION (SHS)

SHS MSHA SEC 504

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-04 Samples

Uncompacted mix

Pavement cores

SD-06 Test Reports

Trial batch reports

Mix design

Asphalt concrete

Density

Thickness

Straightedge test

Submit reports for testing specified under paragraph entitled "Field Quality Control."

SD-07 Certificates

Asphalt mix delivery record

Asphalt concrete and material sources

Obtain approval of the Contracting Officer for materials and material sources 2 days prior to the use of such material in the work.

Asphalt concrete

Submit certificates, signed by the producer, that paving materials and incidental construction items conform to specification requirements.

1.3 QUALITY ASSURANCE

1.3.1 Regulatory Requirements

Provide work and materials in accordance with applicable requirements of SHS MSHA SEC 504.

1.3.2 Modification of References

Where term "Engineer" is used in SHS MSHA 500 it shall be construed to mean Contracting Officer . Where term "state" is used, it shall mean "Federal Government".

1.3.3 Mix Delivery Record Data

Record and submit the following information to each load of mix delivered to the job site. Submit within one day after delivery on Government-furnished forms:

a. Truck No:

b. Time In:

c. Time Out:

d. Tonnage and Discharge Temperature:

e. Mix Type:

f. Location:

g. Stations Placed:

1.3.4 Trial Batch

Submit current bituminous design reports for all mix types proposed for use on the project.

1.3.5 Mix Design

Submit results of laboratory tests performed on each mix design. Testing shall have been accomplished not more than one year prior to date of material placement.

PART 2 PRODUCTS

2.1 ASPHALT CONCRETE

Provide asphalt concrete in accordance with the applicable requirements of the SHS 504, except where specified otherwise.

2.2 SUBBASE

SHS 501, materials for construction of aggregate subbase..

2.3 SURFACE COURSE

SHS 504, materials for construction of the surface course.

2.4 COMPOSITION OF MIXTURE REQUIREMENTS

2.4.1 Mixture Properties

Gradation of mineral aggregate shall be as specified. Percentage of bituminous material provided in the bituminous mixtures shall be within the limits specified. Mixtures shall have the following physical properties:

Test Property	Values
Stability (50 Blows)	Not less than 1000 pounds
Flow (0.01 inch)	Not more than 20 nor less than 8
Percent Air Voids	Not less than 3 nor more than 8 for binder course; not less than 3 nor more than 5 for wearing course
Percent Voids in Mineral Aggregates	See Table I

TABLE I

MINIMUM PERCENT VOIDS IN MINERAL AGGREGATE (VMA)

U.S.A. Standard Sieve Designation	Nominal Maximum Particle Size, Inch	Minimum VMA Percent
No. 4	0.187	18
3/8 inch	0.375	16
1/2 inch	0.500	15
3/4 inch	0.750	14
1 inch	1.000	13

2.4.2 Quantity of Bituminous Material

Mix asphalt cement with aggregates of corresponding mixes in the following proportions:

ASPHALT CEMENT PERCENT BY WEIGHT OF TOTAL MIX

Binder Course	Wearing Course
4 to 8	5 to 9

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Excavation and Filling

Excavation and filling to establish elevation of subgrade is specified in Section 02301N, "Earthwork for Structures and Pavements."

3.2 CONSTRUCTION

Provide construction in accordance with the applicable requirements of the SHS 504, except where indicated or specified otherwise.

3.2.1 Subgrade

SHS 501, preparation of subgrade.

3.2.2 Subbase

SHS 501, methods of construction of the subbase.

3.2.3 Base Course

SHS 501, methods of construction.

3.2.4 Surface Course

SHS 504, methods of construction. Placement will not be permitted unless the Contractor has a working asphalt thermometer on site.

3.3 FIELD QUALITY CONTROL

Sample shall be taken by Contractor as specified herein. Contractor shall replace pavement where sample cores have been removed. Submit 2 pavement cores when using the in-place nuclear density method.

3.3.1 Sample and Core Identification

Place each sample and core in a container and securely seal to prevent loss of material. Tag each sample for identification. Tag shall contain the following information:

a. Contract No.

b. Sample No.

c. Quantity

d. Date of Sample

e. Sample Description

f. Source/Location/Stations Placed/depth below the finish grade

g. Intended Use

h. Thicknesses of various lifts placed

3.3.2 Testing

3.3.2.1 Bituminous Mix Testing

Take two samples per day per mix type at plant or from truck. Test uncompacted mix for extraction in accordance with ASTM D 2172 and sieve analysis in accordance with AASHTO T30. Test samples for stability and flow in accordance with ASTM D 1559. When two consecutive tests fail to meet requirements of specifications, cease placement operations and test a new trial batch prior to resumption of placement operations. Submit 2 per day of each mix type. When two tests on uncompacted mix fail submit new trial batch for approval.

3.3.2.2 Testing of Pavement Course

a. Density: Determine density of pavement by testing cores obtained from the binder and wearing course in accordance with AASHTO T230. Take three cores at location designated by Contracting Officer for each 200 tons, or fraction thereof, of asphalt placed. Deliver cores undisturbed and undamaged to laboratory and provide test results within 48 hours of each day placement of paving materials.

b. Thickness: Determine thickness of the binder and wearing course from cores taken for density test.

c. Straightedge Test: Test compacted surface of binder course and wearing course with a straightedge as work progresses. Apply straightedge parallel with and at right angles to center line after final rolling. Variations in the binder course surface shall not be more than 1/2 inches from the lower edge of the 10 foot straightedge; variations in wearing course surface shall not be more than 1/2 from the lower edge of the 10 foot straightedge. Pavement showing irregularities greater than that specified shall be corrected as directed by Contracting Officer.

3.3.2.3 Alternate Testing Method for Pavement Courses

At Contractor's option the following in-place testing method may be used to determine density and thickness in lieu of testing specified above. Frequency of testing shall be the same. When in-place nuclear method to determine density is used, take two pavement cores at locations designated by Contracting Officer and turn over to Government to verify pavement thickness.

a. Density: Determine density of pavement by in-place testing using Nuclear Method in accordance with ASTM D 2950.

b. Thickness: Determine thickness of finished pavement by use of following equation:

$$t = \frac{W}{0.75d}$$

Where t= pavement thickness, in inches.
W= average weight per square yard of mixture actually used in work.
d= compacted density as measured by nuclear density device.
-- End of Section --

SECTION 02743N

BITUMINOUS PRIME COAT

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 2397	(1994) Cationic Emulsified Asphalt

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE EM-385-1-1	(1996) Safety and Health Requirements Manual

1.2 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-03 Product Data

Cutback asphalt

Submit temperature viscosity relationship.

SD-06 Test Reports

Bituminous materials

1.3 DELIVERY, STORAGE, AND HANDLING

Inspect the materials for contamination and damage. Unload and store the materials with a minimum of handling.

1.4 ENVIRONMENTAL REQUIREMENTS

Apply the prime coat only when the surface is dry or contains moisture not in excess of the amount that will permit uniform distribution and the desired penetration. Apply the prime coat only when the ambient temperature is 50 degrees F or above and when the temperature has not been below 35 degrees F for 12 hours immediately prior to application, unless otherwise directed.

1.5 SAFETY REQUIREMENTS

Perform the work in accordance with COE EM-385-1-1.

1.6 CONSTRUCTION EQUIPMENT

Provide equipment dependable and adequate for the purpose intended and properly maintained in satisfactory and safe operating condition at all times. Calibrated equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by an approved calibration laboratory within 12 months prior to commencing work.

1.6.1 Bituminous Distributor

Bituminous distributor shall have pneumatic tires of such width and number that the load produced on the base surface shall not exceed 650 pounds per inch of tire width. The bituminous distributor shall be designed and equipped to distribute the bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard, with a pressure range of 25 to 75 pounds per square inch and an allowable variation not to exceed 5 percent from any specified rate. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating the materials to the proper application temperature, a thermometer for reading the temperature of the tank contents, and a hose and spray nozzle attachment for applying bituminous material to spots unavoidably missed by the distributor and to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

1.6.2 Heating Equipment for Storage Tanks

The equipment for heating the bituminous material shall be steam, electric, or hot oil heaters. Steam heaters shall consist of steam coils and equipment for producing steam, so designed that the steam cannot get into the material. An armored thermometer with a temperature range from 40 to 400 degrees F shall be fixed to the tank so that the temperature of the bituminous material may be determined at all times.

1.6.3 Brooms and Blowers

Brooms and blowers shall be of the power type and suitable for cleaning prepared subgrades or bases.

PART 2 PRODUCTS

2.1 BITUMINOUS MATERIAL

2.1.1 Emulsified Asphalt

ASTM D 977, Type SS-1 SS1h ASTM D 2397, Type CSS-1 CSS-1h.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Immediately before applying the prime coat, remove loose material, dirt, clay, and other objectionable material from the surface to be primed. After the cleaning operation and prior to the application of the prime coat, examine the area to be primed. Ensure that the area is fit to receive the bituminous priming material.

3.2 APPLICATION

Immediately following the surface preparation, apply the bituminous material by means of the bituminous distributor. Apply the bituminous material at a pressure range of 25 to 75 pounds per square inch within the temperature limits specified herein, and at the rate of not less than 0.20 gallon nor more than 0.30 gallon of bituminous material per square yard. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Unless the distributor is equipped to obtain satisfactory results at the junction of previous and subsequent applications, spread building paper on the surface of the applied material for a sufficient distance back from the ends of each application, so that flow from the sprays may be started and stopped on the paper, and so that all sprayers will operate at full force on the surface to be treated. Immediately after the application, remove the building paper and apply bituminous material to spots missed by the distributor.

3.2.1 Curing

Following the application of bituminous material, allow the surface to cure without being disturbed for a period of not less than 48 hours or longer, as may be necessary to attain penetration into the foundation course and evaporation of the volatiles from the bituminous material. Furnish and spread enough sand to effectively blot up and cure excess bituminous material. Maintain the primed surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and repriming deficient areas.

3.2.2 Application Temperature for Emulsified Asphalt

Between 75 and 130 degrees F.

3.3 FIELD QUALITY CONTROL

Furnish samples of bituminous materials for testing. Sample bituminous materials in accordance with ASTM D 140.

3.4 PROTECTION

Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades to prevent traffic over freshly treated surfaces.

-- End of Section --

SECTION 02811N

IRRIGATION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3261	(1997) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C906	Polyethylene (PE) Pressure Pipe and Fitting, 4 in. through 63 in. for Water Service

1.2 SYSTEM DESCRIPTION

This system is designed with a water pressure minimum of 70 pounds per square inch (psi) at the last head in each zone. If pressure falls above or below indicated values, Contractor shall notify Contracting Officer. For Irrigation Sprinkler System, indicate the following:

a. Head, piping, valve, and controller layout.

b. Provide details of all irrigation components and accessories.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-03 Product Data

Piping materials and fittings

Sprinkler heads

Automatic controller

SD-05 Design Data

System pressure calculations

SD-06 Test Reports

Valves and sprinkler head tests

Pressure test

Operation test including verification of sprinkler head layout

Submit record of pressure tests conducted on recording gage

SD-10 Operation and Maintenance Data

Sprinkler heads and accessories, Data Package 2; G
Submit operation and maintenance data in accordance with Section 01781N, "Operation and Maintenance Data." Include troubleshooting procedures with respect to valve and controller problems.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

Deliver materials in original rolls, packages, cartons, and containers with the name of manufacturer, brand, and model. Inspect materials delivered to the site for damage.

1.4.2 Storage

Store materials on site in enclosures or under protective covering. Store rubber gaskets under cover out of direct sunlight. Do not store materials directly on ground. Keep inside of pipes and fittings free from dirt and debris.

1.4.3 Handling

Handle and carry pipe, fittings, valves, sprinkler heads and accessories in such a manner as to ensure delivery to site in sound undamaged condition. Do not drag pipe.

1.5 EXTRA STOCK

a. 10 additional sprinkler heads (nozzles, bodies, screens, pressure compensating devices);

b. 2 valve keys for operating manual valves;

c. 2 wrenches for removing and installing each type of head;

1.6 QUALITY ASSURANCE

1.6.1 Required Test

Submit tests signed by an authorized official of a testing laboratory of sprinkler head, valve, automatic controller and water hammer arrester.

1.7 WARRANTY

Submit warranty information from sprinkler head manufacturer.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

2.1.1 High Density Polyethylene (PE) Plastic Piping

2.1.1.1 Pipe

AWWA C906, outside diameter (od) base with dimension ratio (DR) of 9.3 to provide 150 psi minimum pressure rating.

2.1.1.2 Fittings

ASTM D 3261, DR of 9.3.

2.2 IRRIGATION SPRINKLER HEADS

2.2.1 Fixed Riser Irrigation Heads

2.2.1.1 Stream Rotors, Part Circle

The part circle impulse drive sprinkler shall be a single nozzle type, capable of covering 170 feet radius, at 70 PSI with a discharge rate of 36 GPM. The sprinkler body and bearing sleeve shall be of heat treated, cast aluminum or like material.

Straightening vanes shall be integral to the body. The drive nozzle trajectory shall be 23 degrees from horizontal.

The rotation of the sprinkler shall be accomplished by a spring loaded, stainless steel vertical oscillating arm, actuated by the outlet water stream. The sprinkler shall have a slow-reverse feature for reduced vibration and greater safety. A stainless steel spoon bracket assembly can be adjusted to increase or decrease rotation speed.

The bearing assembly shall be permanently sealed and packed with a wide temperature range, water resistant silicone grease. The brake mechanism will be spring loaded and self-adjusting.

Adjustable friction collars will be supplied to set arc adjustements without the use of tools, and the bearing assembly will be marked in ten degree increments to facilitate adjustments.

Sprinklers shall be large orifice (0.4 inch or larger nozzle) agricultural guns. Acceptable manufacturer's include:

a. Rain Brid Rain Gun
b. Nelson Irrigation Big Gun
c. NAAN Irrigation Giant Metal Sprinklers
d. Acceptable Substitute

PART 3 EXECUTION

3.1 INSTALLATION

Install sprinkler system after site grading has been completed.

3.1.1 Piping Installation

3.1.1.1 Polyethylene (PE) Pipe Connection to Metal Riser

Connect sprinkler supply line to 2-inch stainless steel riser using a stainless steel flange/backup ring of IPP deltaflex type SS-SDR or acceptable substitute.

3.1.2 Irrigation Heads

Install plumb and level with terrain.

3.1.2.1 Fixed Riser Irrigation Heads

Nozzle mounted on fixed riser a minimum of 3 feet above grade.

3.2 FIELD QUALITY CONTROL

The Contractor will conduct and the Contracting Officer and the QC representative will witness field inspections and field tests specified in this section. Perform field tests, and provide labor, equipment, and incidentals required for testing.

3.2.1 Pressure Test

3.2.1.1 Duration

During pressure test, maintain a hydrostatic pressure of 150 psi without pumping for a period of one hour with an allowable pressure drop of 5 psi before backfilling system.

3.2.1.2 Leaks

Correct leaks. Make necessary corrections to stop leakage.

3.2.1.3 Retest

Retest system twice until pressure can be maintained for duration of test.

3.2.2 Operation Test

3.2.2.1 Accessories

At conclusion of pressure test, install irrigation heads, and test entire system for operation under normal operating pressure. Make necessary corrections or adjustments to raise or lower pressure for each system if tests results do not match pressure requirements.

3.2.2.2 Acceptance

Operation test is acceptable if system operates through at least one complete cycle for areas to be irrigated.

-- End of Section --

SECTION 02921A

SEEDING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602 (1995a) Agricultural Liming Materials

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act (1995) Federal Seed Act Regulations Part 201

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment; G

Manufacturer's literature including physical characteristics, application and installation instructions for equipment, surface erosion control material and chemical treatment material.

A listing of equipment to be used for the seeding operation.

Delivery; G

Delivery schedule.

Maintenance Record; G

Maintenance work performed, area repaired or reinstalled, diagnosis for unsatisfactory stand of grass plants.

SD-07 Certificates

Plant Material; G
pH Adjuster; G
Fertilizer; G
Prior to the delivery of materials, certificates of compliance attesting that materials meet the specified requirements.

Certified copies of the material certificates shall include the following:

a. Seed. Classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.

b. pH Adjuster. Calcium carbonate equivalent and sieve analysis.

c. Fertilizer. Chemical analysis and composition percent.

1.3 SOURCE INSPECTION

The source of delivered topsoil shall be subject to inspection.

1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.4.1.1 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

1.4.2 Inspection

Seed shall be inspected upon arrival at the job site for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, shall be rejected. Other materials shall be inspected for compliance with specified requirements. The following shall be rejected: open soil amendment containers or wet soil amendments. Unacceptable materials shall be removed from the job site.

1.4.3 Storage

Materials shall be stored in designated areas. Seed, lime, and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with seeding operation materials.

1.4.4 Handling

Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Seed Classification

State-certified seed of the latest season's crop shall be provided in

original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS Seed Act and applicable state seed laws.

2.1.2 Permanent Seed Species and Mixtures

Permanent seed species and mixtures shall be proportioned by weight as follows:

Pure Botanical Name	Common Name	Mixture Percent by Weight	Pounds Per Acre (Live Seed)
Andropogon scoparis	Little Bluestem	10	2.7
	FIELD SEED		
Panicum clandestinum	Deertongue	2	0.5
Andropogon gerardii	Big Bluestem	10	2.8
Panicum virgatum	Switchgrass	15	4.1
Panicum amarum	Atlantic Coastal Panicgrass	15	4.1
Elymus canadensis	Canadian Wild Rye	10	2.7
Rudbekia hirta	Black Eyed Susan	1	0.3
Bidens connata	Beggarstick	1	0.3
Siteria italica	Foxtail Millet	36	10

2.1.3 Temporary Seed Species

Temporary seed species for surface erosion control or overseeding shall be as follows:

Botanical Name	Common Name	Pounds Per Acre (Pure Live Seed)
Siteria italica	Foxtail Millet	10

2.1.4 Quality

Weed seed shall be a maximum 1 percent by weight of the total mixture.

2.1.5 Seed Mixing

The mixing of seed may be done by the seed supplier prior to delivery, or on site as directed.

2.1.6 Substitutions

Substitutions will not be allowed without written request and approval from the Contracting Officer.

2.2 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster meeting the following requirements. Vermiculite shall not be used.

2.2.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, sulfur, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

2.2.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a No. 8 sieve and a minimum 55 percent shall pass through a No. 60 sieve. To raise soil pH, ground limestone shall be used.

PART 3 EXECUTION

3.1 INSTALLING SEED TIME AND CONDITIONS

3.1.1 Seeding Time

Seed shall be installed from May 1 to June 30 for spring establishment.

3.1.2 Seeding Conditions

Seeding operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the seeding operations, proposed alternate times shall be submitted for approval.

3.1.3 Equipment Calibration

Immediately prior to the commencement of seeding operations, calibration tests shall be conducted on the equipment to be used. These tests shall confirm that the equipment is operating within the manufacturer's specifications and will meet the specified criteria. The equipment shall be calibrated a minimum of once every day during the operation. The calibration test results shall be provided within 1 week of testing.

3.2 SITE PREPARATION

3.2.1 Finished Grade and Topsoil

The Contractor shall verify that finished grades are in accordance with Section 02300A EARTHWORK, prior to the commencement of the seeding operation.

3.2.2 Application of Soil Amendments

3.2.2.1 Applying pH Adjuster

The application rate shall be 1653 pounds per 1000 square yards. The pH adjuster shall be incorporated into the soil to a maximum 4 inch depth or may be incorporated as part of the tillage operation.

3.3 INSTALLATION

Prior to installing seed, any previously prepared surface compacted or damaged shall be reworked to meet the requirements of paragraph SITE PREPARATION. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

3.3.1 Installing Seed

Seeding method shall be Drill Seeding . Seeding procedure shall ensure even coverage. Gravity feed applicators, which drop seed directly from a hopper onto the prepared soil, shall not be used because of the difficulty in achieving even coverage, unless otherwise approved.

3.3.1.1 Drill Seeding

Seed shall be uniformly drilled to a maximum 1/2 inch depth and at the rate of 0.63 pounds per 1000 square feet, using equipment having drills a maximum 7 inches distance apart. Row markers shall be used with the drill seeder. Half the total rate of seed application shall be drilled in 1 direction, with the remainder of the seed rate drilled at 90 degrees from the first direction. The drilling equipment shall be maintained with half full seed boxes during the seeding operations.

3.4 SURFACE EROSION CONTROL

3.4.1 Temporary Seeding

The application rate shall be 2.07 pounds per 1000 square yards. When directed during contract delays affecting the seeding operation or when a quick cover is required to prevent surface erosion, the areas designated shall be seeded in accordance with temporary seed species listed under Paragraph SEED.

3.5 RESTORATION AND CLEAN UP

3.5.1 Clean Up

Excess and waste material shall be removed from the seeded areas and shall be disposed offsite.

3.6 SEED ESTABLISHMENT PERIOD

3.6.1 Commencement

The seed establishment period to obtain a healthy stand of grass plants shall begin on the first day of seeding work under this contract and shall continue through the remaining life of the contract and end 3 months after the last day of the seeding operation required by this contract. Written calendar time period shall be furnished for the seed establishment period. When there is more than 1 seed establishment period, the boundaries of the seeded area covered for each period shall be described. The seed establishment period shall be coordinated with Sections 02922A SODDING, 02923A SPRIGGING, and 02930A EXTERIOR PLANTING. The seed establishment period shall be modified for inclement weather, shut down periods, or for separate completion dates of areas.

-- End of Section --

SECTION 02923A

SPRIGGING

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment; G
Chemical Treatment Material; G

Manufacturer's literature, including physical characteristics, application and installation instructions for equipment and chemical treatment material.

A listing of equipment to be used for the sprigging operation.

Application of Pesticide; g

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

1.2 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.2.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.2.1.1 Pesticides

Pesticide material shall be delivered to the site in the original, unopened containers, bearing legible labels indicating the EPA registration number and the manufacturer's registered uses.

1.2.2 Storage

1.4.3.2 Other Material Storage

Materials shall be stored in designated areas. Seed, lime, and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions

and not with plant material or other materials.

PART 2 PRODUCTS

2.1 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification, soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

PART 3 EXECUTION

3.1 INSTALLATION

Prior to installing sprigs, any previously prepared surface compacted or damaged shall be reworked to meet the requirements of paragraph SITE PREPARATION. Areas shall be sprigged as indicated.

3.2 APPLICATION OF PESTICIDE

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

3.2.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

3.2.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

-- End of Section --

SECTION 02930A

EXTERIOR PLANTING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NURSERY AND LANDSCAPE ASSOCIATION (ANLA)

ANLA Z60.1 (1996) Nursery Stock

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawings; G

Scale drawings defining areas to receive plant materials.

SD-03 Product Data

Equipment; G

A listing of equipment to be used for the planting operation.

Delivery; G

Delivery schedule.

Plant Establishment Period; G

Calendar time period for the plant establishment period. When there is more than one establishment period, the boundaries of the planted areas covered for each period shall be described.

Maintenance Record; G

Maintenance work performed, quantity of plant losses, and replacements; and diagnosis of unhealthy plant material.

SD-07 Certificates

Plant Material; G
pH Adjuster; G

Fertilizer; g

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

a. Plant Material: Classification, botanical name, common name, size, quantity by species, and location where grown.

c. pH Adjuster: Sieve analysis and calcium carbonate equivalent.

d. Fertilizer: Chemical analysis and composition percent.

SD-10 Operation and Maintenance Data

Maintenance Instructions; G

Instruction for year-round care of installed plant material.

1.3 DELIVERY, INSPECTION, STORAGE, AND HANDLING

1.3.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

1.3.1.1 Plant Material Identification

Plant material shall be identified with attached, durable, waterproof labels and weather-resistant ink, stating the correct botanical plant name and size.

1.3.1.2 Protection During Delivery

Plant material shall be protected during delivery to prevent desiccation and damage to the branches, trunk, root system, or earth ball. Branches shall be protected by tying-in. Exposed branches shall be covered during transport.

1.3.1.3 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

1.3.1.4 Pesticide Material

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses.

1.3.2 Inspection

Plant material shall be well shaped, vigorous and healthy with a healthy, well branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion. Plant material shall be

checked for unauthorized substitution and to establish nursery grown status. Plant material showing desiccation, abrasion, sun-scald injury, disfigurement, or unauthorized substitution shall be rejected. The plant material shall exhibit typical form of branch to height ratio; and meet the caliper and height measurements specified. Plant material that measures less than specified, or has been poled, topped off or headed back, shall be rejected. Container-grown plant material shall show new fibrous roots and the root mass shall contain its shape when removed from the container. Plant material with broken or cracked balls; or broken containers shall be rejected. Bare-root plant material that is not dormant or is showing roots were pulled from the ground shall be rejected. Other materials shall be inspected for compliance with paragraph PRODUCTS. Open soil amendment containers or wet soil amendments shall be rejected.

1.3.3 Storage

1.3.3.1 Plant Material Storage

Plant material not installed on the day of arrival at the site shall be stored and protected in designated areas. Plant material shall not be stored longer than 30 days. Plant material shall be protected from direct exposure to wind and sun. All plant material shall be kept in a moist condition by watering with a fine mist spray until installed.

1.3.3.2 Other Material Storage

Storage of other material shall be in designated areas. Soil amendments shall be stored in dry locations and away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with planting operation material.

1.3.4 Handling

Plant material shall not be injured in handling. Cracking or breaking the earth ball of balled and burlapped plant material shall be avoided. Plant material shall not be handled by the trunk or stems. Materials shall not be dropped from vehicles.

1.4 WARRANTY

Furnished plant material shall have a warranty for plant growth to be in a vigorous growing condition for a minimum 12 month period. A minimum 12 month calendar time period for the warranty of plant growth shall be provided regardless of the contract time period. When plant material is determined to be unhealthy in accordance with paragraph PLANT ESTABLISHMENT PERIOD, it shall be replaced once under this warranty.

PART 2 PRODUCTS

2.1 PLANT MATERIAL

2.1.1 Plant Material Classification

The plant material shall be nursery grown stock conforming to ANLA Z60.1 and shall be the species specified.

2.1.2 Plant Schedule

The plant schedule shall provide botanical names as included in one or more

of the publications listed under "Nomenclature" in ANLA Z60.1.

2.1.3 Substitutions

Substitutions will not be permitted without written request and approval from the Contracting Officer.

2.1.4 Quality

Well shaped, well grown, vigorous plant material having healthy and well branched root systems in accordance with ANLA Z60.1 shall be provided. Plant material shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plant material shall be free of shock or damage to branches, trunk, or root systems, which may occur from the digging and preparation for shipment, method of shipment, or shipment. Plant quality is determined by the growing conditions; method of shipment to maintain health of the root system; and growth of the trunk and crown as follows.

2.1.5 Growing Conditions

Plant material shall be native to or well-suited to the growing conditions of the project site. Plant material shall be grown under climatic conditions similar to those at the project site.

2.1.6 Method of Shipment to Maintain Health of Root System

2.1.6.1 Container-Grown (C) Plant Material

Container size shall be in accordance with ANLA Z60.1. Plant material shall be grown in a container over a duration of time for new fibrous roots to have developed and for the root mass to retain its shape and hold together when removed from the container. The container shall be sufficiently rigid to hold ball shape and protect root mass during shipping.

2.1.7 Growth of Trunk and Crown

2.1.7.1 Deciduous Trees

A height to caliper relationship shall be provided in accordance with ANLA Z60.1. Height of branching shall bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

a. Single stem: The trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Multi-stem: All countable stems, in aggregate, shall average the size specified. To be considered a stem, there shall be no division of the trunk which branches more than 6 inches from ground level.

c. Specimen: The tree provided shall be well branched and pruned naturally according to the species. The form of growth desired, which may not be in accordance with natural growth habit, shall be as indicated.

2.1.7.2 Deciduous Shrubs

Deciduous shrubs shall have the height and number of primary stems recommended by ANLA Z60.1. Acceptable plant material shall be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.

2.1.8 Plant Material Size

Plant material shall be furnished in sizes indicated. Plant material larger in size than specified may be provided at no additional cost to the Government.

2.2 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, organic material and soil conditioners meeting the following requirements.

2.2.1 Fertilizer

Fertilizer shall be controlled release commercial grade, tablet, uniform in composition, and consist of a 20:10:5 nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coasted urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients. Fertilizer tablets shall be applied in the following quantities:

Stock	Number of Tablets
2" peat pot or plug	1
Quart	1
2-3'	2
3-4'	3
4-5	4
5-6	4

2.2.2 Organic Material

Organic material shall consist of composted material available on-site and shall be added to the planting soil backfill for all shrubs and trees..

2.2.2.1 Recycled Compost

Compost shall be a well-decomposed, stable, weed free organic matter source. It shall be derived from on-site stockpiles. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 3/8 inch screen, possess a pH of 5.5 to 8.0, and have moisture content between 35-55 percent be weight. The material shall not contain more than 1 percent or less by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 2 inches in length.

2.2.3 Soil Conditioner

Soil conditioner shall be sand, super absorbent polymers and shall only be used for shrubs and trees..

2.2.3.1 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized according to manufacturer's recommendations. Polymers shall be added as a soil amendment and be cross-linked polyacrylamide with an absorption capacity of 250-400 times its weight.

2.3 MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum shall be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

2.4 WATER

Unless otherwise directed, water shall be the responsibility of the Contractor. Water shall not contain elements toxic to plant life.

PART 3 EXECUTION

3.1 INSTALLING PLANT MATERIAL TIME AND CONDITIONS

3.1.1 Deciduous Plant Material Time

Deciduous woody plant material shall be installed from October 1 to April 30. Deciduous herbaceous plant material shall be install from April 30 to June 1.

3.1.2 Evergreen Plant Material Time

Evergreen plant material shall be installed from October 1 to April 30.

3.1.3 Plant Material Conditions

Planting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted for approval.

3.2 SITE PREPARATION

3.2.1 Finished Grade, Topsoil and Underground Utilities

The Contractor shall verify that finished grades are as indicated on drawings, and that the placing of topsoil, the smooth grading, and the compaction requirements have been completed in accordance with Section 02300A EARTHWORK, prior to the commencement of the planting operation. The location of underground utilities and facilities in the area of the planting operation shall be verified. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

3.2.2 Layout

Plant material locations are to follow planting plan notes. Plant material locations may be adjusted to meet field conditions.

3.3 INSTALLATION

3.3.1 Setting Plant Material

Plant material shall be set plumb and held in position until sufficient soil has been firmly placed around root system or ball. In relation to the surrounding grade, the plant material shall be set even with the grade at which it was grown.

3.3.2 Adding Mycorrhizal Fungi Inoculum

Mycorrhizal fungi inoculum shall be added as recommended by the manufacturer for the plant material specified.

3.3.3 Container-Grown and Balled and Potted Plant Material

The plant material shall be carefully removed from containers that are not biodegradeable. Prior to setting the plant in the pit, a maximum 1/4 depth of the root mass, measured from the bottom, shall be spread apart to promote new root growth. For plant material in biodegradable containers the container shall be split prior to setting the plant with container. Backfill mixture shall be added to the plant pit in 6 inch layers with each layer tamped.

3.3.3.1 Earth Berm

An earth berm, consisting of backfill soil mixture, shall be formed with a minimum 4 inch height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

3.3.4 Watering

Plant pits shall be watered immediately after backfilling, until completely saturated.

3.3.5 Staking and Guying

Staking will be required when trees are unstable or will not remain set due to their size, shape, or exposure to high wind velocity.

3.4 RESTORATION AND CLEAN UP

3.4.1 Clean Up

Excess and waste material shall be removed from the installed area and shall be disposed offsite. Adjacent paved areas shall be cleared.

3.5 PLANT ESTABLISHMENT PERIOD

3.5.1 Commencement

The plant establishment period for maintaining exterior plantings in a healthy growing condition shall commence on the first day of exterior planting work under this contract and shall continue through the remaining life of the contract and end 12 months after the last day of exterior planting required by this contract. Written calendar time period shall be furnished for the plant establishment period. When there is more than one plant establishment period, the boundaries of the planted area covered for each period shall be described. The plant establishment period shall be coordinated with Sections 02921A SEEDING; and 02923A SPRIGGING. The plant establishment period shall be modified for inclement weather shut down periods, or for separate completion dates for areas.

3.5.2 Maintenance During Establishment Period

Maintenance of plant material shall include straightening plant material, supplementing mulch; pruning dead or broken branch tips; watering; eradicating weeds, insects and disease; and removing and replacing unhealthy plants.

3.5.3 Unhealthy Plant Material

A shrub shall be considered unhealthy or dead when up to a maximum 50 percent of the plant has died. Unhealthy or dead plant material shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

3.5.4 Replacement Plant Material

Unless otherwise directed, plant material shall be provided for replacement in accordance with paragraph PLANT MATERIAL. Replacement plant material shall be installed in accordance with paragraph INSTALLATION, and recommendations in paragraph PLANT ESTABLISHMENT PERIOD. Plant material shall be replaced in accordance with paragraph WARRANTY. An extended plant establishment period shall not be required for replacement plant material.

-- End of Section --

ADDENDUM TO SECTION 02930A-EXTERIOR PLANTING

SPECIAL PROVISION FOR
VEGETATION CONTROL
HART MILLER ISLAND SOUTH CELL ENVIRONMENTAL RESTORATION

April 12, 2002

I. DESCRIPTION

This work shall consist of activities intended to control or eradicate invasive species in the project areas designated for upland grasses and forest. These areas are noted on the plans at the site designated as the South Cell, Section 1135. This effort includes the application of approved herbicides and mowing of existing invasive plant populations. All work will be performed in accordance with this provision, the plans, and as directed by the Engineer.

Invasive plant control in the areas designated at South Cell on the plans includes control of Common Reed (*Phragmites australis).*

II. MATERIALS

The herbicide shall be EPA registered and approved for use over water. The glyphosate herbicide Rodeo® (or equal) is approved for this use.

III. PROCEDURES

The contractor shall notify the engineer at least 48 hours prior to beginning work. Herbicide application is strictly regulated, and the contractor must ensure that all federal and state regulations are followed.

Initial control efforts must be undertaken prior to any soil disturbing activities such as mowing or grading. Mowing and grading can facilitate the spread of the invasive species by redistribution of pieces of rhizomes.

All of the sites are in or adjacent to existing wetlands and open water, and therefore the herbicide used must be approved for use over water. Rodeo® (or equal) must be mixed with water and a surfactant that will allow it to stick to and subsequently be absorbed by the plant. The labeled concentrations for spray solutions must be adhered to in accordance with federal regulations. The contractor must ensure that the herbicide applicator is certified by the state. The contractor shall be responsible for obtaining all necessary permits prior to initiating application.

Timing of spraying must be during the growing season, but no later than September 30. Application shall be by rotarywing sprayship with a microfoil boom.

The South Cell Site has extensive stands of common reed occupying large portions of the site. Vegetative control at this site will be achieved through initial spraying of the common reed stands, followed by mowing, and then follow up applications of herbicide. The common reed stand should sprayed and then be mowed no more than four inches above the ground. The cut material will be left on-site.

During the warranty period following seeding of the south cell, spot application with spray equipment shall be used to control regrowth of phragmites in the upland areas.

IV. MEASUREMENT AND PAYMENT

Herbicide application will be measured in units of herbicide applied, and will be paid for at the contract unit price per acre. Mowing of plants prior to the second herbicide application will be considered a part of the contract unit price. Additional work required to ensure invasive plant species control during the one year maintenance period will be paid for on a per acre basis. This price shall include furnishing and applying herbicide; mowing as designated on the plan sheets and in this special provision.

Payment will be made under:

Pay Item	Pay Unit
Herbicide application	Acres

SECTION 03200A

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 318/318R	(1995) Building Code Requirements for Structural Concrete and Commentary

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1999) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 82	(1997a) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 184/A 184M	(1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 675/A 675M	(1990a; R 1995e1) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A 706/A 706M	(1998) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 767/A 767M	(1997) Zinc-Coated (Galvanized) Steel Bars in Concrete Reinforcement
ASTM A 775/A 775M	(1997e1) Epoxy-Coated Reinforcement Steel Bars
ASTM A 884/A 884M	(1996ae1) Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement
ASTM C 1116	(1995) Fiber-Reinforced Concrete and Shotcrete

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4 (1998) Structural Welding Code - Reinforcing Steel

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI MSP-1 (1996) Manual of Standard Practice

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcement; G

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

SD-03 Product Data

Welding; G

A list of qualified welders names.

SD-07 Certificates

Reinforcing Steel; G

Certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

1.3 WELDING

Welders shall be qualified in accordance with AWS D1.4. Qualification test shall be performed at the worksite and the Contractor shall notify the Contracting Officer 24 hours prior to conducting tests. Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4.

1.4 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

PART 2 PRODUCTS

2.1 DOWELS

Dowels shall conform to ASTM A 675/A 675M, Grade 80. Steel pipe conforming to ASTM A 53, Schedule 80, may be used as dowels provided the ends are closed with metal or plastic inserts or with mortar.

2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184/A 184M.

2.3 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615/A 615M or ASTM A 706/A 706M, grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82. In highly corrosive environments or when directed by the Contracting Officer, reinforcing steel shall conform to ASTM A 767/A 767M or ASTM A 775/A 775M as appropriate.

2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to ASTM A 185 . When directed by the Contracting Officer for special applications, welded wire fabric shall conform to ASTM A 884/A 884M.

2.5 WIRE TIES

Wire ties shall be 16 gauge or heavier black annealed steel wire.

2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall have wire ties and shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

2.7 SYNTHETIC FIBER REINFORCEMENT

Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inches.

PART 3 EXECUTION

3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318/318R. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. Wire tie ends shall face away from the forms.

3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other

deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318/318R at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318/318R. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.2 Splicing

Splices of reinforcement shall conform to ACI 318/318R and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Welding shall conform to AWS D1.4. Welded butt splices shall be full penetration butt welds. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6 inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.2 WELDED-WIRE FABRIC PLACEMENT

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. Fabric placement at joints shall be as indicated. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWEL INSTALLATION

Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately positioned and aligned parallel to the finished concrete surface before concrete placement. Dowels shall be rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

3.4 SYNTHETIC FIBER REINFORCED CONCRETE

Fiber reinforcement shall be added to the concrete mix in accordance with the applicable sections of ASTM C 1116 and the recommendations of the manufacturer, and in an amount of 0.1 percent by volume.

3.5 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

Special inspections and testing for seismic-resisting systems and components shall be done in accordance with Section 01452 SPECIAL

INSPECTION FOR SEISMIC-RESISTING SYSTEMS.

-- End of Section --

SECTION 03201

STEEL BARS AND WELDED WIRE FABRIC FOR CONCRETE REINFORCEMENT FOR CIVIL WORKS

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 315	(1999) Details and Detailing of Concrete Reinforcement
ACI 318/318R	(1999) Building Code Requirements for Structural Concrete and Commentary

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 184/A 184M	(1996) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 370	(1997a) Mechanical Testing of Steel Products
ASTM A 615/A 615M	(2000) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4	(1998) Structural Welding Code - Reinforcing Steel

1.2 UNIT PRICES

1.2.1 Deformed Steel Bars for Concrete Reinforcement

1.2.1.1 Payment

Payment will be made for costs associated with furnishing and placing deformed steel bars for concrete reinforcement. Payment for steel in laps will be made as indicated or required. No payment will be made for additional steel in laps wherein the additional steel lap was made for the convenience of the Contractor.

1.2.1.2 Measurement

Deformed Steel Bars for Concrete Reinforcement will be measured for payment based upon the quantity of pounds in place. The measured lengths will be converted to weights for the size of bars listed by the use of the nominal weights per linear foot specified in ASTM A 615/A 615M.

1.2.1.3 Unit of Measure

Unit of measure: per pound.

1.2.2 Accessories

No payment will be made for costs associated with furnishing and placing accessories incidental to and included in the payment for other items of work.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication and Placement; G

The Contractor shall submit shop drawings which include: reinforcement steel placement drawings; reinforcement steel schedules showing quantity, size, shape, dimensions, weight per foot, total weights and bending details; and details of bar supports showing types, sizes, spacing and sequence.

SD-03 Product Data

Butt-Splices; G

The Contractor shall submit the proposed procedure for butt-splicing steel bars prior to making the test butt-splices for qualification of the procedure. Properties and analyses of steel bars and splicing materials shall be included in the submitted procedure. Physical properties of splicing sleeves shall include length, inside and outside diameters, and inside surface details.

Materials; G

A system of identification which shows the disposition of specific lots of approved materials in the work shall be established and submitted before completion of the contract.

SD-06 Test Reports

Material; G
Tests, Inspections, and Verifications; G

Certified tests reports of reinforcement steel showing that the steel complies with the applicable specifications shall be furnished for each steel shipment and identified with specific lots prior to placement. Three copies of the heat analyses shall be provided for each lot of steel furnished and the Contractor shall certify that the steel conforms to the heat analyses.

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall conform to the following requirements.

2.1.1 Steel Bars

Steel bars shall comply with the requirements of ASTM A 615/A 615M , deformed, of the grades, sizes and lengths shown.

2.1.1.1 Fabricated Bar Mats

Fabricated bar mats shall comply with the requirements of ASTM A 184/A 184M, clipped or welded mats, bar sizes and spacings as shown.

2.1.2 Accessories

2.1.2.1 Bar Supports

Bar supports shall comply with the requirements of ACI 315. Supports for bars in concrete with formed surfaces exposed to view or to be painted shall be plastic-coated wire, stainless steel or precast concrete supports. Precast concrete supports shall be wedged-shaped, not larger than 3-1/2 by 3-1/2 inches, of thickness equal to that indicated for concrete cover and have an embedded hooked tie-wire for anchorage. Bar supports used in precast concrete with formed surfaces exposed to view shall be the same quality, texture and color as the finish surfaces.

2.1.2.2 Wire Ties

Wire ties shall be 16 gage or heavier black annealed wire. Ties for epoxy-coated bars shall be vinyl-coated or epoxy-coated. Ties for zinc-coated bars shall be zinc-coated.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

The Contractor shall have material tests required by applicable standards and specified performed by an approved laboratory and certified to demonstrate that the materials are in conformance with the specifications. Tests, inspections, and verifications shall be performed and certified at the Contractor's expense.

2.2.1 Reinforcement Steel Tests

Mechanical testing of steel shall be in accordance with ASTM A 370 except as otherwise specified or required by the material specifications. Tension tests shall be performed on full cross-section specimens using a gage length that spans the extremities of specimens with welds or sleeves included. Chemical analyses of steel heats shall show the percentages of carbon, phosphorous, manganese, sulphur and silicon present in the steel.

PART 3 EXECUTION

3.1 FABRICATION AND PLACEMENT

Reinforcement steel and accessories shall be fabricated and placed as specified and shown and approved shop drawings. Fabrication and placement details of steel and accessories not specified or shown shall be in accordance with ACI 315 and ACI 318/318R or as directed. Steel shall be fabricated to shapes and dimensions shown, placed where indicated within specified tolerances and adequately supported during concrete placement. At the time of concrete placement all steel shall be free from loose, flaky

rust, scale (except tight mill scale), mud, oil, grease or any other coating that might reduce the bond with the concrete.

3.1.1 Hooks and Bends

Steel bars, except for zinc-coated or epoxy-coated, shall be mill or field-bent. Zinc-Coated and epoxy-coated bars shall be mill-bent prior to coating. All steel shall be bent cold unless authorized. No steel bars shall be bent after being partially embedded in concrete unless indicated or authorized.

3.1.2 Welding

Welding of steel bars will be permitted only where indicated or authorized. Welding shall be performed in accordance with AWS D1.4 except where otherwise specified or indicated.

3.1.3 Placing Tolerances

3.1.3.1 Spacing

The spacing between adjacent bars and the distance between layers of bars may not vary from the indicated position by more than one bar diameter nor more than 1 inch.

3.1.3.2 Concrete Cover

The minimum concrete cover of main reinforcement steel bars shall be as shown. The allowable variation for minimum cover shall be as follows:

MINIMUM COVER	VARIATION
3 inch	plus 3/8 inch
2 inch	plus 1/4 inch

3.1.4 Splicing

Splices in steel bars shall be made only as required. Bars may be spliced at alternate or additional locations at no additional cost to the Government subject to approval.

3.1.4.1 Lap Splices

Lap splices shall be used only for bars smaller than size 14 and welded wire fabric. Lapped bars may be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than 1/5 the required length of lap or 6 inches.

-- End of Section --

SECTION 03301A

CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214	(1977; R 1997) Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 305R	(1999) Hot Weather Concreting
ACI 318/318R	(1999) Building Code Requirements for Structural Concrete and Commentary

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31/C 31M	(2000) Making and Curing Concrete Test Specimens in the Field
ASTM C 39/C 39M	(1999) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	(1999) Organic Impurities in Fine Aggregates for Concrete
ASTM C 42/C 42M	(1999) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 87	(1983; R 1995e1) Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM C 127	(1988; R 1993e1) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1997) Specific Gravity and Absorption of Fine Aggregate
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates

ASTM C 143/C 143M	(2000) Slump of Hydraulic Cement Concrete
ASTM C 150	(1999a) Portland Cement
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 192/C 192M	(2000) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1997e1) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2000) Air-Entraining Admixtures for Concrete
ASTM C 309	(1998a) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494/C 494M	(1999a) Chemical Admixtures for Concrete
ASTM C 566	(1997) Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 597	(1983; R 1997) Pulse Velocity Through Concrete
ASTM C 666	(1997) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 803/C 803M	(1997e1) Penetration Resistance of Hardened Concrete
ASTM C 805	(1997) Rebound Number of Hardened Concrete
ASTM C 881	(1999) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 1059	(1999) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064/C 1064M	(1999) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1999) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D 75	(1987; R 1997) Sampling Aggregates

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 94	(1995) 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 318	(1979) Cloth, Burlap, Jute (or Kenaf)
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

1.2 UNIT PRICES

1.2.1 Concrete for Pump Station

1.2.1.1 Payment

Payment will be made for costs associated with completing the concrete work for concrete placed in the pump station. However, these costs will not include the cost of embedded parts that are specified to be paid for separately. No payment will be made for concrete, as such, that is placed in structures of which payment is made as a lump sum.

1.2.1.2 Measurement

Concrete will be measurement for payment based upon the actual volume of concrete within the pay lines of the structures as indicated on the drawings. Measurement of concrete 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, or for voids or embedded items that are either less than 5 cubic feet in volume or 1 square foot in cross section.

1.2.1.3 Unit of Measure

Unit of measure: cubic yards.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete Mixture Proportioning, G

Concrete mixture proportions shall be determined by the Contractor and submitted for review. The concrete mixture

quantities of all ingredients per cubic yard and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete shall be stated. Proportions shall indicate the mass of cement, pozzolan and ground granulated blast-furnace (GGBF) slag when used, and water; the mass of aggregates in a saturated surface-dry condition; and the quantities of admixtures. The submission shall be accompanied by test reports from a laboratory complying with ASTM C 1077 which show that proportions thus selected will produce concrete of the qualities indicated. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the quality of the new materials and concrete are satisfactory.

Batch Plant; G

The Contractor shall submit batch plant data to the Contracting Officer for review for conformance with applicable specifications.

Concrete Mixers; G
Capacity; G

The Contractor shall submit concrete mixer data which includes the make, type, and capacity of concrete mixers proposed for mixing concrete.

Conveying Equipment; G

The conveying equipment and methods for transporting, handling, and depositing the concrete shall be submitted for review by the Contracting Officer for conformance with paragraphs CAPACITY and CONVEYING EQUIPMENT.

Placing Equipment; G

All placing equipment and methods shall be submitted for review by the Contracting Officer for conformance with paragraph CAPACITY.

Tests and Inspections; G
Testing Technicians; G
Concrete Transportation Construction Inspector (CTCI); G

The Contractor shall submit statements that the concrete testing technicians and the concrete inspectors meet the specified requirements.

Construction Joint Treatment; G

The method and equipment proposed for joint cleanup and waste disposal shall be submitted for review and approval.

Curing and Protection; G

The curing medium and methods to be used shall be submitted for review and approval.

Cold-Weather Placing; G

If concrete is to be placed under cold-weather conditions, the proposed materials, methods, and protection shall be submitted for

approval.

Hot-Weather Placing; G
Finishing; G

If concrete is to be placed under hot-weather conditions, the proposed materials and methods shall be submitted for review and approval.

SD-04 Samples

Aggregates; G
Cementitious Materials, Admixtures, and Curing Compound; G

Samples of materials for government testing and approval shall be submitted as required in paragraph PRECONSTRUCTION SAMPLING AND TESTING.

SD-06 Test Reports

Quality of Aggregates; G

Aggregate quality tests shall be submitted at least 30 days prior to start of concrete placement.

Mixer Uniformity; G.

The results of the initial mixer uniformity tests shall be submitted at least 5 days prior to the initiation of placing.

Tests and Inspections; G

Test results and inspection reports shall be submitted daily and weekly as required in paragraph REPORTS.

1.4 GOVERNMENT TESTING AND SAMPLING

The Government will sample and test aggregates and concrete to determine compliance with the specifications. The Contractor shall 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 ASTM D 75. Concrete will be sampled in accordance with ASTM C 172.

1.4.1 Preconstruction Sampling and Testing

1.4.1.1 Aggregates

The aggregate sources listed at the end of this section for aggregates 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 selected by the Contractor, consisting of not less than 150 pounds of each size coarse aggregate and 75 pounds of fine aggregate taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100 shall be delivered to a site approved by the Contracting Officer within 15 days after notice to proceed. Sampling and shipment of samples shall be at the Contractor's

expense. Seven (7) 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 the applicable COE CRD-C 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. 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. Testing of aggregates by the Government does not relieve the Contractor of the requirements outlined in paragraph TESTS AND INSPECTIONS.

1.4.1.2 Cementitious Materials, Admixtures, and Curing Compound

At least 60 days in advance of concrete placement, the Contractor shall notify the Contracting Officer of the sources for cementitious materials, admixtures, and curing compound, along with sampling location, brand name, type, and quantity to be used in the manufacture and/or curing of the concrete.

1.4.2 Construction Testing by the Government

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.

1.4.2.1 Chemical Admixtures Storage

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 of paragraph CHEMICAL ADMIXTURES.

1.4.2.2 Cement

If cement 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.

a. 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 Corps of Engineers, Engineer Research and Development Center - Structures Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEERD-SC.

c. 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 request of the Contractor, at his 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.

1.4.2.3 Concrete Strength

Compressive strength test specimens will be made by the Government and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 500 psi. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including nondestructive testing, taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

a. Investigation of Low-Strength Test Results - When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 500 psi or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803/C 803M, or ASTM C 805 may be permitted by the Contracting Officer to estimate the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests shall not be used as a basis for acceptance or rejection.

b. Testing of Cores - When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42/C 42M. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the performance of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement.

c. Load Tests - If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test shall be corrected in a manner satisfactory to the Contacting Officer. All

investigations, testing, load tests, and correction of deficiencies will be performed and approved by the Contracting Officer at the expense of the Contractor, except that if all concrete is in compliance with the plans and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

1.5 DESIGN REQUIREMENTS

1.5.1 Concrete Strength

Specified compressive strength f'c shall be as follows:

COMPRESSIVE STRENGTH (PSI)	STRUCTURE OR PORTION OF STRUCTURE
4,000 @ 28 days	Whole Pump Station

1.6 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 by the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Portland Cement

ASTM C 150, Type I or II, except that the maximum amount of C3A in Type I cement shall be 15 percent.

2.1.2 Cementitious Materials

2.1.3 Aggregates

2.1.3.1 General

Concrete aggregates may be furnished from any source capable of meeting the approval of the Contracting Officer.

2.1.3.2 Concrete Aggregate Sources

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

b. Selection of Source - After the award of the contract, the Contractor shall designate in writing only one source or combination of sources from which he proposes to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or from sources not listed at the end of this section, he may designate only a single source or single combination of sources for aggregates. Regardless of the source, selected samples for acceptance testing shall be provided as required by paragraph GOVERNMENT TESTING AND SAMPLING. If a source for coarse or fine aggregates so designated by the Contractor does not meet the quality requirements stated in paragraph QUALITY, the Contractor may not submit for approval other non-listed 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.

2.1.4 Chemical Admixtures

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

2.1.4.1 Air-Entraining Admixture

The air-entraining admixture shall conform to ASTM C 260 and shall consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.1.4.2 Accelerating Admixture

Accelerators shall meet the requirements of ASTM C 494/C 494M, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

2.1.4.3 Water-Reducing or Retarding Admixture

a. Water-Reducing or Retarding Admixtures: ASTM C 494/C 494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.

b. High-Range Water Reducing Admixture: ASTM C 494/C 494M, Type F or G except that the 6-month and 1-year strength requirements shall be waived. The admixture may be used only when approved by the Contracting Officer, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan.

2.1.5 Curing Materials

2.1.5.1 Impervious-Sheet Curing Materials

Impervious-sheet curing materials shall conform to ASTM C 171, type optional, except polyethylene film shall not be used.

2.1.5.2 Membrane-Forming Curing Compound

The membrane-forming curing compound shall conform to ASTM C 309, 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 or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, coating, or flooring specified. Nonpigmented compound shall contain a fugitive dye and shall have the reflective requirements in ASTM C 309 waived.

2.1.5.3 Burlap

Burlap used for curing shall conform to COE CRD-C 318.

2.1.6 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.

2.1.7 Nonshrink Grout

Nonshrink grout shall conform to ASTM C 1107 and shall be a commercial formulation suitable for the application proposed.

2.1.8 Abrasive Aggregates

Fifty-five percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. The aggregate shall be well graded from particles retained on the 600-µm (No. 30) sieve to particles passing the 2.36-mm (No. 8) sieve.

2.1.9 Latex Bonding Compound

Latex bonding compound agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

2.1.10 Epoxy Resin

Epoxy resin for use in repairs shall conform to ASTM C 881, Type III, Grade I or II.

2.2 CONCRETE MIXTURE PROPORTIONING

2.2.1 Quality of Mixture

For each portion of the structure, mixture proportions shall be selected so that the strength and W/C requirements listed in paragraph DESIGN REQUIREMENTS are met.

2.2.2 Nominal Maximum-Size Coarse Aggregate

Nominal maximum-size coarse aggregate shall be 1 inch inches except 19.0 mm (3/4 inch) nominal maximum-size coarse aggregate shall be used when any of the following conditions exist: the narrowest dimension between sides of forms is less than 7-1/2 inches, the depth of the slab is less than 4 inches, or the minimum clear spacing between reinforcing is less than 2-1/4 inches.

2.2.3 Air Content

Air content as delivered to the forms and as determined by ASTM C 231 shall be between 4 and 7 percent except that when the nominal maximum-size coarse aggregate is 3/4 inch, it shall be between 4-1/2 and 7-1/2 percent.

2.2.4 Slump

The slump shall be determined in accordance with ASTM C 143/C 143M and shall be within the range of 1 to 4 inch. Where placement by pump is approved, the slump shall not exceed 6 inches.

2.2.5 Concrete Proportioning

Trial batches and testing requirements for various qualities of concrete specified shall be the responsibility of the Contractor. Samples of aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregate shall be representative of

those proposed for the project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios, which will produce a range of strength encompassing those required for the work. The maximum water-cement ratios required in paragraph MAXIMUM WATER-CEMENT RATIO will be converted to a weight ratio of water to cement plus pozzolan by mass, silica fume, or GGBF slag by mass equivalency as described in ACI 211.1. In the case where GGBF slag is used, the weight 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. Trial mixtures shall be proportioned for maximum permitted slump and air content with due consideration to the approved conveying and placement method. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192/C 192M. They shall be tested at 7 days and at the design age specified in paragraph DESIGN REQUIREMENTS in accordance with ASTM C 39/C 39M. From these test results, a curve will be plotted showing the relationship between water-cement ratio and strength.

2.2.6 Required Average Compressive Strength

In meeting the strength requirements specified in paragraph CONCRETE STRENGTH, the selected mixture proportion shall produce a required average compressive strength f'cr exceeding the specified strength f'c by the amount indicated below.

2.2.6.1 Average Compressive Strength from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected, shall represent concrete produced to meet a specified strength or strengths (f'c) within 1,000 psi of that specified for proposed work, and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another test age designated for determination of f'c.

Required average compressive strength f'cr used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'cr = f'c + 1.34S$$
$$f'cr = f'c + 2.33S - 500$$

Where S = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS*	MODIFICATION FACTOR FOR STANDARD DEVIATION Use tabulation in paragraph DETERMINING REQUIRED AVERAGE STRENGTH
less than 15	
15	1.16
20	1.08
25	1.03
30 or more	1.00

*Interpolate for intermediate numbers of tests.

2.2.6.2 Average Compressive Strength without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength fcr shall be determined as follows:

If the specified compressive strength f'c is 3,000 to 5,000 psi,

$$f'cr = f'c + 1,200$$

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 Concrete Mixers

The concrete mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

3.1.1.1 Stationary Mixers

Concrete plant mixers shall be tilting, nontilting, horizontal-shaft, vertical-shaft, or pugmill and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94/C 94M applicable to central-mixed concrete.

3.1.2 Conveying Equipment

The conveying equipment shall conform to the following requirements.

3.1.2.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yards shall not be manually operated. The design of

the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.1.2.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

3.1.2.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94/C 94M. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

3.1.2.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.1.2.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer 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 at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches. The belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars.

3.1.2.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Aluminum pipe shall not be used.

3.1.3 Vibrators

Vibrators of the proper size, frequency, and amplitude shall be used for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER INCHES	FREQUENCY VPM	AMPLITUDE INCHES
General construction	2 to 3-1/2	8,000 to 12,000	0.025 to 0.05

The frequency and amplitude shall be determined in accordance with COE CRD-C 521.

3.2 PREPARATION FOR PLACING

3.2.1 Embedded Items

Before placement of concrete, care shall be taken 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 concrete into voids. Welding, including tack welding, will not be permitted on embedded metals within 2 feet of the surface of the concrete.

3.2.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the earth foundation shall have been satisfactorily compacted.

3.2.3 Construction Joint Treatment

Construction joint treatment shall conform to the following requirements.

3.2.3.1 Joint Preparation

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning with either 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. There shall be no standing water on the surface upon which concrete is placed.

3.2.3.2 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 90 to 110 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, the Contractor shall furnish samples of the material to be used and shall 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.

3.2.3.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 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.

3.2.3.4 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.

3.2.3.5 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.

3.3 PLACING

3.3.1 Placing Procedures

The surfaces of horizontal construction joints shall be kept continuously wet for the first 12 hours during the 24-hour period prior to placing concrete. Surfaces may be dampened immediately before placement if necessary. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation. Concrete shall be deposited as close as possible to its final position in the forms and, in so depositing, there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers 2.0 feet or less in thickness with a minimum of lateral movement. The amount deposited in each location shall be that which can be readily and thoroughly consolidated. Sufficient placing capacity shall be provided so that concrete placement can be kept plastic and free of cold joints while concrete is being placed. Concrete shall be placed by methods that will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper that is conical in shape. The concrete shall not be dropped vertically more than 5 feet, except where a properly designed and sized elephant truck with rigid drop chute bottom section is provided to prevent segregation and where specifically authorized. In no case will concrete be discharged to free-fall through reinforcing bars.

3.3.2 Placement by Pump

When concrete is to be placed by pump, the nominal maximum-size coarse aggregate shall not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms. Grout used to lubricate the pumping equipment at the beginning of the placement will not be incorporated into the placement.

3.3.3 Time Interval Between Mixing and Placing

Concrete shall be placed within 30 minutes after discharge into nonagitating equipment. When concrete is truck-mixed or when a truck mixer or agitator is used for transporting concrete mixed by a concrete plant mixer, the concrete shall be delivered to the site of the work, and discharge shall be completed within 1-1/2 hours after introduction of the cement to the aggregates. When the length of haul makes it impossible to deliver truck-mixed concrete within these time limits, batching of cement and a portion of the mixing water shall be delayed until the truck mixer is at or near the construction site.

3.3.4 Cold-Weather Placing

When cold-weather placing of concrete is likely to be subjected to freezing temperatures before the expiration of the curing period, it shall be placed in accordance with procedures previously submitted in accordance with paragraph SUBMITTALS. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32 degrees F. The placing temperature of the concrete having a minimum dimension less than 12 inches shall be between 55 and 75 degrees F when measured in accordance with ASTM C 1064/C 1064M. The placing temperature of the concrete having a minimum dimension greater than 12 inches shall be between 50 and 70 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals, or other materials shall not be mixed with the concrete to prevent freezing.

3.3.5 Hot-Weather Placing

Concrete shall be properly placed and finished with procedures previously submitted in accordance with paragraph SUBMITTALS. The concrete-placing temperature shall not exceed 85 degrees F when measured in accordance with ASTM C 1064/C 1064M. Cooling of the mixing water and aggregates, or both, may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph WATER-REDUCING OR RETARDING ADMIXTURES 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 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

3.3.6 Consolidation

Immediately after placement, each layer of concrete, including flowing concrete, shall be consolidated by internal vibrating equipment. Vibrators shall not be used to transport concrete within the forms. Hand spading may be required, if necessary, with internal vibrating along formed surfaces

permanently exposed to view. Form or surface vibrators shall not be used unless specifically approved. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding unhardened layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly.

3.4 FINISHING

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 40 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 exceed0.2 pounds per square foot 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. 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 on the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown in the drawing or as directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or jitterbugs shall not be used.

3.4.1 Unformed Surfaces

3.4.1.1 Trowel Finish

A trowel finish shall be applied to all interior surfaces. Concrete surfaces shall be finished with a float finish, and after surface moisture has disappeared, the surface shall be troweled to a smooth, even, dense finish free from blemishes including trowel marks.

3.4.1.2 Broom Finish

A broom finish shall be applied to exterior surfaces. The concrete surface shall be finished with a float finish. The floated surface shall be broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

3.4.2 Formed Surfaces

Unless another finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired as described in paragraph FORMED SURFACE REPAIR.

TYPES OF FINISH	STRUCTURE OR PORTION OF STRUCTURE
Grout-cleaned	Exterior surface below grade

Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that is exposed to

view or on which a special finish is required. The form panels used to produce the finish shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features.

3.4.2.1 Grout-Cleaned Finish

The surfaces of exterior surface below grade shall be given a grout-cleaned finish as described, as approved by the Contracting Officer and after all required curing, cleaning, and repairs have been completed. Surfaces to be grout-cleaned shall be moist cured for the required period of time before application of the grout-cleaned finish. Grout-cleaning shall be delayed until near the end of construction on all surfaces not to be painted in order to achieve uniformity of appearance and reduce the chance of discoloring caused by subsequent construction operations. The temperature of the air adjacent to the surface shall be not less than 40 degrees F for 24 hours prior to and 72 hours following the application of the finish. The finish for any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the finished surface. The surface to receive grout-cleaned finish shall be thoroughly wetted to prevent absorption of water from the grout but shall have no free water present. The surface shall then be coated with grout. The grout shall be applied as soon as the surface of the concrete approaches surface dryness and shall be vigorously and thoroughly rubbed over the area with clean burlap pads, cork floats or stones, so as to fill all voids. The grout shall be composed of one part portland cement as used on the project, to two parts by volume of well-graded sand passing a 600-µm (No. 30) sieve mixed with water to the consistency of thick paint. White portland cement shall be used for all or part of the cement as approved by the Contracting Officer to give the desired finish color. The applied coating shall be uniform, completely filling all pits, air bubbles, and surface voids. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, burlap pad, or other means. Then, after the surface whitens from drying (about 30 minutes at normal temperature) rub vigorously with clean burlap pads. Immediately after rubbing is completed, the finished surface shall be continuously moist cured for 72 hours. Burlap pads used for this operation shall be burlap stretched tightly around a board to prevent dishing the mortar in the voids.

3.4.3 Formed Surface Repair

After removal of forms, all ridges, lips, and bulges on surfaces permanently exposed shall be removed. All repairs shall be completed within 48 hours after form removal.

3.4.3.1 Material and Procedure for Repairs

The cement used in the dry-packed mortar or replacement concrete shall be a blend of the cement used for production of project concrete and white portland cement properly proportioned so that the final color of the mortar or concrete will match adjacent concrete. Trial batches shall be used to determine the proportions required to match colors. Dry-packed mortar shall consist of one part cement to two and one-half parts fine aggregate. The fine aggregate shall be that used for production of project concrete. The mortar shall be remixed over a period of at least 30 minutes without addition of water until it obtains the stiffest consistency that will permit placing. Mortar shall be thoroughly compacted into the prepared void by tamping, rodding, ramming, etc. and struck off to match adjacent concrete. Replacement concrete shall be produced using project materials

and shall be proportioned by the Contracting Officer. It shall be thoroughly compacted into the prepared void by internal vibration, tamping, rodding, ramming, etc. and shall be struck off and finished to match adjacent concrete. Forms shall be used to confine the concrete. If an expanding agent is used in the repair concrete, the repair shall be thoroughly confined on all sides including the top surface. Metal tools shall not be used to finish permanently exposed surfaces. The repaired areas shall be cured for 7 days. The temperature of the in situ concrete, adjacent air, and replacement mortar or concrete shall be above40 degrees F during placement, finishing, and curing. Other methods and materials for repair may be used only when approved in writing by the Contracting Officer. Repairs of the so called "plaster-type" will not be permitted.

3.5 CURING AND PROTECTION

3.5.1 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.

Type I portland cement _____ 7 days

Immediately after placement, 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 prior to the start of concrete placement. 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.

3.5.2 Moist Curing

Moist-cured concrete 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. 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 so as to continuously saturate the entire concrete surface. Horizontal surfaces may be moist cured by ponding, by covering with a minimum uniform thickness of 2 inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Horizontal construction joints may be allowed to dry for 12 hours immediately prior to the placing of the following lift. Silica fume concrete, if used, shall be moist-cured. Curing of silica fume concrete shall start immediately after placement.

3.6 SETTING OF BASE PLATES AND BEARING PLATES

3.6.1 Setting of Plates

After being plumbed and properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be provided with full bearing with nonshrink

grout. The space between the top of concrete or masonry-bearing surface and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 1/2 inch for plates less than 12 inches wide. Concrete surfaces shall be rough, clean, and free of oil, grease, and laitance, and they shall be damp. Metal surfaces shall be clean and free of oil, grease, and rust.

3.6.2 Nonshrink Grout Application

Nonshrink grout shall conform to the requirements of paragraph NONSHRINK GROUT. Water content shall be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.6.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or masonry-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for retaining the grout and shall be removed after the grout has set. If grade "A" grout as specified in ASTM C 1107 is used, all surfaces shall be formed to provide restraint. The placed grout shall be worked to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting.

3.6.2.2 Treatment of Exposed Surfaces

After the grout has set, those types containing metallic aggregate shall have the exposed surfaces cut back 1 inch and immediately covered with a parge coat of mortar proportioned by mass of one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat shall have a smooth, dense finish. The exposed surface of other types of nonshrink grout shall have a smooth, dense finish.

3.6.2.3 Curing

Grout and parge coats shall be cured in conformance with paragraph CURING AND PROTECTION.

3.7 TESTS AND INSPECTIONS

Tests and inspections shall conform to the following requirements.

3.7.1 General

The Contractor shall perform the inspections and tests 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 C 1077. 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). 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 C 1077.

3.7.2 Testing and Inspection Requirements

3.7.2.1 Fine Aggregate

a. 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 C 136 and COE CRD-C 104 for the fine aggregate or for each size range of 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.

b. 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.

c. 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 C 566 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 shown to be out of control or excessive variation in workability is reported by the placing foreman. When the 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.

d. 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 slump.

3.7.2.2 Coarse Aggregate

a. Grading - At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 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. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. 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 mixer to allow for degradation during handling.

b. 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. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

c. Coarse Aggregate Moisture Content - A test for moisture content of each size group of coarse aggregate shall be made at least twice per week. 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 above for fine aggregate, until the difference falls below 1.0 percent.

d. Coarse Aggregate Moisture Corrective Action - Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more, the scale setting for the coarse aggregate batcher and the water batcher shall be adjusted if necessary to maintain the specified slump.

3.7.2.3 Quality of Aggregates

a. Frequency of Quality Tests - Thirty days prior to the start of concrete placement the Contractor shall perform all tests for aggregate quality listed below. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

PROPERTY	FREQUENCY FINE AGGREGATE	FREQUENCY COARSE AGGREGATE	TEST
Specific Gravity	ASTM C 127		ASTM C 128
Absorption	ASTM C 127		ASTM C 128
Durability Factor Using, (Procedure A)	ASTM C 666		COE CRD-C 114
Impurities	ASTM C 40		ASTM C 87

b. Corrective Action for Aggregate Quality - If the result of a quality test fails to meet the requirements for quality 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.

3.7.2.4 Scales

a. Weighing Accuracy - The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

b. 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. The Contractor shall confirm that the calibration devices described in paragraph BATCH PLANT for checking the accuracy of dispensed admixtures are operating properly.

c. Scales Corrective Action - When either 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.

3.7.2.5 Batch-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. 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 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 batch aggregate and water weights per cubic yard for each class of concrete batched during plant operation.

3.7.2.6 Concrete Mixture

a. 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 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 quality assurance representative. Tests shall be made in accordance with ASTM C 231. 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 either the upper or lower action limit a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the

batch to plot on both the control chart for air content and the control chart for range, and for determining 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. 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 concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content 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.

b. 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 concreting is restarted. All this shall be at no extra cost to the Government.

c. Slump Testing - In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143/C 143M for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. 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 slump test reaches or goes beyond either 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 and this average used as the slump of the batch to plot on both the control chart for percent air and the chart for range, and for determining the need for any remedial action. An upper warning limit shall be set at 1/2 inch below the maximum allowable slump on separate control charts for percent air used for each type of mixture as specified in paragraph SLUMP, and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump 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 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 mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer and the slump at the mixer controlled as directed.

d. Slump Corrective Action - Whenever points on the control chart for slump 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 slump reaches the upper or lower action limit, no further concrete 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 slump 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 concreting operation shall immediately be halted and the Contractor shall take appropriate steps to bring the slump under control. Also, additional slump tests shall be made as directed. All this shall be at no additional cost to the Government.

e. Temperature - The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064/C 1064M. The temperature shall be reported along with the compressive strength data.

f. Compressive-Strength Specimens - At least one set of test specimens shall be made each day on each different 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 sampling plan shall be developed by the Contractor and approved by the Contracting Officer 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 per paragraph DESIGN REQUIREMENTS shall consist of four cylinders, two to be tested at 7 days and two at 28 days. A set of test specimens for concrete with a 90-day strength per specified paragraph DESIGN REQUIREMENTS shall consist of six cylinders, two tested at 7 days, two at 28 days, and two at 90 days. Test specimens shall be molded and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M. 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 214.

3.7.2.7 Inspection Before Placing

Foundation or construction joints, forms, and embedded items shall be inspected for quality by the Contractor 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.

3.7.2.8 Placing

a. Placing Inspection - The placing foreman shall supervise all placing operations, shall determine that the correct quality of concrete or grout is placed in each location as directed and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, yardage placed, and method of placement.

b. Placing Corrective Action - The placing foreman shall not permit batching and placing to begin until he has verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.7.2.9 Vibrators

a. Vibrator Testing and Use - The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521prior 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 at the same time the vibrator is operating in concrete with the tachometer 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.

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

3.7.2.10 Curing

a. 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.

b. 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 one (1) day.

3.7.2.11 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.

3.7.2.12 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.

3.7.2.13 Mixer Uniformity

a. Stationary Mixers - Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 75,000 cubic yards of concrete placed, whichever results in the longest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94/C 94M.

b. Truck Mixers - Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete shall be determined in accordance with ASTM C 94/C 94M. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

3.7.2.14 Mixer Uniformity Corrective Action

When a mixer fails to meet mixer uniformity requirements, either the mixer shall be removed from service on the work, the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.7.3 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 test and inspection records.

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LIST OF FINE AND COARSE AGGREGATE SOURCES

LAT/LONG	PIT LOCATION, ADDRESS AND TELEPHONE NUMBER	MAIN OFFICE, ADDRESS AND TELEPHONE NUMBER
	FINE AGGREGATE	
___/___		
___/___		
___/___		
___/___		
___/___		
	COARSE AGGREGATE	
___/___		
___/___		
___/___		
___/___		
___/___		

-- End of Section --

SECTION 03311

MARINE CONCRETE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M182	(1991; R 1996) Burlap Cloth Made From Jute or Kenaf

ACI INTERNATIONAL (ACI)

ACI 117	(1990) Tolerances for Concrete Construction and Materials
ACI 121R	(1985) Quality Assurance Systems for Concrete Construction
ACI 201.2R	(1992) Durable Concrete
ACI 211.1	(1991) Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214	(1977; R 1989) Evaluation of Strength Test Results of Concrete
ACI 301	(1996) Structural Concrete
ACI 304R	(1989) Measuring, Mixing, Transporting, and Placing Concrete
ACI 304.2R	(1996) Placing Concrete by Pumping Methods
ACI 305R	(1991) Hot Weather Concreting
ACI 306.1	(1990) Cold Weather Concreting
ACI 308	(1992) Curing Concrete
ACI 311.1R	(1992) ACI Manual of Concrete Inspection
ACI 309R	(1996) Consolidation of Concrete
ACI 315	(1992) Details and Detailing of Concrete Reinforcement
ACI 318/318M	(1995) Building Code Requirements for Structural Concrete

ACI 347R	(1994) Formwork for Concrete
ACI SP-2	(1992) ACI Manual of Concrete Inspection
ACI SP-15	(1995) Structural Concrete for Buildings ACI 301 with Selected ACI and ASTM References

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82	(1997) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 185	(1997) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 496	(1997) Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497	(1997) Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 615/A 615M	(1996; Rev. A) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996; Rev. A) Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996; Rev. A) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 934/A 934M	(1997) Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM C 31/C 31M	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1997) Concrete Aggregates
ASTM C 39	(1996) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	(1994) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 94	(1997) Ready-Mixed Concrete
ASTM C 138	(1992) Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
ASTM C 143	(1990; Rev. A) Slump of Hydraulic Cement Concrete
ASTM C 150	(1997) Portland Cement
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 172	(1997) Sampling Freshly Mixed Concrete

ASTM C 173	(1994; Rev. A) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 227	(1990) Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 295	(1990) Petrographic Examination of Aggregates for Concrete
ASTM C 309	(1997) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 441	(1996) Effectiveness of Mineral Admixtures or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to Alkali-Silica Reaction
ASTM C 469	(1994) Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 496	(1996) Splitting Tensile Strength of Cylindrical Concrete Specimens
ASTM C 595	(1994; Rev. A) Blended Hydraulic Cements
ASTM C 597	(1983; R 1991) Pulse Velocity Through Concrete
ASTM C 618	(1997) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 642	(1997) Density Gravity, Absorption, and Voids in Hardened Concrete
ASTM C 805	(1994) Rebound Number of Hardened Concrete
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM C 989	(1997) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	(1992) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1064	(1986; R 1993) Temperature of Freshly Mixed Portland Cement Concrete

ASTM C 1077	(1997) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1997) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1157	(1994; Rev. A) Blended Hydraulic Cement
ASTM C 1202	(1997) Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
ASTM C 1218/C 1218M	(1997) Water-Soluble Chloride in Mortar and Concrete
ASTM C 1240	(1997) Silica Fume for Use in Hydraulic-Cement Concrete and Mortar
ASTM C 1260	(1994) Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM D 512	(1989; R 1994) Chloride Ion in Water
ASTM D 516	(1990; R 1995) Sulfate Ion in Water
ASTM D 1179	(1993) Fluoride Ion in Water
ASTM D 1190	(1996) Concrete Joint Sealer, Hot-Applied Elastic Type
ASTM D 1339	(1990) Sulfite in Water
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 3867	(1990) Nitrite-Nitrate in Water
ASTM E 329	(1995; Rev. C) Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C-61	(1974) Determining the Resistance of Freshly Mixed Concrete to Washing Out in Water
COE CRD-C-572	(1974) Polyvinylchloride Waterstop

1.2 DEFINITIONS

a. "Blending size" is an aggregate that complies with the quality

requirements in ASTM C 33 and paragraph entitled "Aggregates" and as modified herein and can be blended with coarse and fine aggregate to produce a well graded combined grading.

b. "Cementitious material" as used herein shall include portland cement, pozzolan, fly ash, ground granulated blast-furnace slag.

c. "Design strength" (f'c) is the specified compressive strength of concrete to meet structural design criteria.

d. "Marine concrete" is that concrete that will be in contact with or subject to submersion, tidal variations, splash, or spray from water in navigable waterways.

e. "Mixture proportioning" is a description of the proportions of a concrete mixture that were selected to enable it to meet the performance durability requirements, constructability requirements, and the initial and life-cycle cost goals.

f. "Mixture proportions" is the concrete supplier's by-mass proportions to replicate the mixture design.

g. "Pozzolan" is a silicious or silicious and aluminous material, which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

h. "Field test strength" (fcr) is the required compressive strength of concrete to meet structural and durability criteria. Determine (fcr) during mixture proportioning process.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Reinforcing steel; G

Formwork

Construction joints

Reproductions of contract drawings are unacceptable.

SD-03 Product Data

Waterstops

Materials for curing concrete

Joint sealants

Joint filler

Epoxy bonding compound

Synthetic reinforcing fibers

Epoxy coatings

Non-shrink grout

Sealer-hardener

Preformed joint filler

Reinforcement supports

SD-05 Design Data

Mixture design; G

SD-06 Test Reports

Concrete mixture proportions

Fly ash

Natural pozzolan

Ground iron blast-furnace slag

Silica fume

Aggregates

Admixtures

Cement

Water

Reinforcement and protective coating; G

SD-07 Certificates

Curing concrete elements

Form removal schedule

Concrete placement and compaction

Quality assurance

Field testing technician and testing agency

Mixture designs

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" had been substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to the "Building Official," the "Structural Engineer," and the

"Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. ACI 301 and ASTM A 934/A 934M for job site storage of materials. Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Concrete Mixture Design

At least 30 days prior to concrete placement, submit proportions for a concrete mixture for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, aggregate, fly ash, (or slag pozzolans), silica fume, ground slag, polypropylene fibers, anti-washout and other admixtures for underwater concreting, corrosion inhibitors; and applicable reference specifications. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submittal shall clearly indicate where each mixture will be used when more than one mix design is submitted. An identical concrete mixture previously approved within the past 12 months by the Army Corps of Engineers, may be used without further approval, if copies of the previous approval and aggregate, fly ash, silica fume, and pozzolan test results are submitted. The approval of aggregate, fly ash, silica fume, and pozzolan tests results shall have been within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement. The mixture shall be prepared by an accredited laboratory experienced in this field and under the direction of a licensed/registered civil engineer, who shall sign all reports and designs. Refer to Section 01450N, "Quality Control."

1.6.2 Drawings

1.6.2.1 Reinforcing Steel

ACI 315. Provide bending and cutting diagrams, assembly diagrams, splicing placement and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Only complete drawings will be accepted.

1.6.2.2 Formwork

ACI 347R. Include design calculations indicating arrangement of forms, sizes and grades of supports (lumber), panels, and related components. Indicate placement schedule, construction, and location and method of forming control joints. Include locations of inserts, pipework, conduit, sleeves, and other embedded items. Furnish drawings and descriptions of shoring and reshoring methods proposed for slabs, beams, and other horizontal concrete members.

1.6.3 Certificates

1.6.3.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.6.3.2 Form Removal Schedule

Submit schedule for form removal indicating element and minimum length of time for form removal. Submit technical literature of forming material or liner, form release agent, form ties, and gasketing to prevent leakage at form and construction joints. Provide a full description of materials and methods to be used to patch form-tie holes.

1.6.3.3 Concrete Placement and Compaction

a. Submit technical literature for equipment and methods proposed for use in placing concrete. Include pumping or conveying equipment including type, size and material for pipe, valve characteristics, and the maximum length and height concrete will be pumped. No adjustments shall be made to the mixture design to facilitate pumping.

b. Submit technical literature for equipment and methods proposed for vibrating and compacting concrete. Submittal shall include technical literature describing the equipment including vibrator diameter, length, frequency, amplitude, centrifugal force, and manufacturer's description of the radius of influence under load. Where flat work is to be cast, provide similar information relative to the proposed compacting screed or other method to ensure dense placement.

1.6.3.4 Quality Assurance

Develop and submit for approval a quality control plan in accordance with the guidelines of ACI 121R and as specified herein. The plan shall include plans for the concrete supplier, the reinforcing steel supplier, and installer. Maintain a copy of ACI SP-15 and CRSI Manual of Practice at the project site.

1.6.3.5 Field Testing Technician and Testing Agency

Submit data on qualifications of proposed testing agency and technicians for approval by the Contracting Officer prior to performing any work.

a. Work on concrete under this contract shall be performed by an ACI Concrete Field Testing Technician Grade 1 or Grade 2 qualified in accordance with ACI SP-2 or equivalent. Equivalent certification programs shall include requirements for written and performance examinations as stipulated in ACI SP-2.

b. Testing agencies that perform testing services on reinforcing steel shall meet the requirements of ASTM E 329.

c. Testing agencies that perform testing services on concrete materials shall meet the requirements of ASTM C 1077.

1.6.3.6 Mixture Designs

Provide a detailed report of materials and methods used, test results, and the field test strength (fcr) for marine concrete required to meet durability requirements.

1.6.4 Test Reports

1.6.4.1 Concrete Mixture Proportions

a. Submit copies of test reports by independent test labs conforming to ASTM C 1077 showing that the mixture has been successfully tested to produce concrete with the properties specified and that mixture will be suitable for the job conditions. Test reports shall be submitted along with the concrete mixture proportions. Obtain approval before concrete placement.

b. Fully describe the processes and methodology whereby mixture proportions were developed and tested and how proportions will be adjusted during progress of the work to achieve, as closely as possible, the designated levels of relevant properties.

1.6.4.2 Fly Ash and Natural Pozzolan

Submit test results in accordance with ASTM C 618. Submit test results performed within 6 months of submittal date.

1.6.4.3 Ground Iron Blast-Furnace Slag

Submit test results in accordance with ASTM C 989 for ground iron blast-furnace slag. Submit test results performed within 6 months of submittal date.

1.6.4.4 Silica Fume

Submit test results in accordance with ASTM C 1240 for silica fume. Data shall be based upon tests performed within 6 months of submittal.

1.6.4.5 Aggregates

Submit test results for aggregate quality in accordance with ASTM C 33, and the combined graduation curve for grading proposed for use in the work and used in the mixture qualification, and ASTM C 295 for results of petrographic examination. Where there is potential for alkali-silica reaction, provide results of tests conducted in accordance with ASTM C 227 or ASTM C 1260. Submit results of all tests during progress of the work in tabular and graphical form as noted above, describing the cumulative combined aggregate grading and the percent of the combined aggregate retained on each sieve.

1.6.4.6 Admixtures

Submit test results in accordance with ASTM C 494 and ASTM C 1017 for concrete admixtures, ASTM C 260 for air-entraining agent, and manufacturer's literature and test reports for corrosion inhibitor and anti-washout admixture. Submitted data shall be based upon tests performed within 6 months of submittal.

1.6.4.7 Cement

Submit test results in accordance with ASTM C 150 portland cement and/or ASTM C 595 and ASTM C 1157 for blended cement. Submit current mil data.

1.6.4.8 Water

Submit test results in accordance with ASTM D 512 and ASTM D 516.

1.6.4.9 Reinforcement and Protective Coating

Provide coating manufacturer's and coating applicator's test data sheets certifying that applied coating meets the requirements of ASTM A 934/A 934M.

1.6.5 Field Samples

1.6.5.1 Slab Finish Sample

Install minimum of 10 by 10 foot slab. Finish as required by specification.

1.6.5.2 Underwater Concrete Sample

Place concrete in four 5 gallon buckets below water. Permanently mark as "7 days," "14 days," "28 days," and "Extra." Include date and station. Provide a minimum of one specimen set per day of underwater concrete placement. Retrieve specimens at specified intervals. Extract 4 inch diameter by 10 inch long core and test in accordance with ASTM C 39.

PART 2 PRODUCTS

2.1 CONCRETE

2.1.1 Durability and Strength

ACI 201.2R and ACI 211.1. For structural elements to be exposed in a marine environment, adjust the concrete 28-day design strength to produce concrete of minimum design strength (f'c) of 5000 psi.

2.1.2 Contractor-Furnished Mixture Proportions

a. Strength and Water-Cementitious Materials Ratio. Strength requirements shall be based on 28-day compressive strength determined on 6 by 12 inch cylindrical specimens in accordance with ASTM C 39. The specified compressive strength of the concrete (f'c) for each portion of the structure shall meet the requirements in the contract documents.

b. The mixture proportions for marine concrete shall be developed by the Contractor to produce the design strength (f'c) and to provide durability, workability, and mixture consistency to facilitate placement, compaction into the forms and around reinforcement without segregation or bleeding. The requirements for durability consideration specified in Table 1 and subparagraph "f" below shall be incorporated in the mixture proportions.

Table 1 - Concrete Quality Requirements

Zone	Exposure Condition	Maximum W/CM	Minimum quantity of cementitious material lb/yd3	Minimum quantity of portland cement lb/yd3
Submerged (1) and tidal (2)	(a) Directly exposed to salt	0.40	675	505

Table 1 - Concrete Quality Requirements

Zone	Exposure Condition	Maximum W/CM	Minimum quantity of cementitious material lb/yd3	Minimum quantity of portland cement lb/yd3
	water			
	(b) Subject to severe abrasion	0.40	675	505
Splash (3)	(a) Directly exposed to salt water	0.40	675	505
Atmospheric (4)	(a) Directly exposed to marine atmosphere	0.40	675	505
	(b) Protected from direct exposure to marine atmosphere	0.45	607	505

c. The maximum mass of fly ash, natural pozzolans, ground granulated blast-furnace slag, or silica fume that is included in the calculation of water-to-cementitious materials ratio shall not exceed the following limits:

(1) Fly ash shall not be used for more than 25 percent by mass of the cementitious material. The fly ash and other pozzolans present in a Type IP or IPM blended cement, ASTM C 595, shall be included in the calculated percentage. If fly ash or other pozzolan is used in concrete with slag, the portland cement shall not be less than 50 percent of the total mass of cementitious materials. A higher percentage of fly ash may be used if tests are made using actual job materials to ascertain the early and later age strengths and durability performance specified, and the use is approved by the Contracting Officer.

(2) The weight of ground granulated blast-furnace slag conforming to ASTM C 989 shall not exceed 50 percent of the weight of cement. The slag used in manufacture of a Type IS or ISM blended hydraulic cement conforming to ASTM C 595 shall be included in the calculated percentage. Higher percentage of ground granulated blast-furnace slag may be used if tests are made using actual job materials to ascertain the early and later age strengths and durability performance specified, and the use is approved by the owner.

(3) The maximum silica fume content shall not exceed 10 percent by mass of the cementitious material. The silica fume shall originate from the manufacture of silicon metal and ferro-silicon alloys. A high-range water reducer shall be used with silica fume for proper dispersion of the silica fume.

(4) The minimum amount of portland cement is 50 percent of the

total mass of cementitious material.

d. Air Content. Concrete that will be subject to destructive exposure (other than loading and wear in a passive environment) such as freezing and thawing, severe weathering, or deicing chemicals shall be air entrained and shall conform to the air limits specified in ACI 301.

e. Slump. The concrete mixture shall be proportioned to have, at the point of deposit, a maximum slump of 4 inches as determined by ASTM C 143. Where an ASTM C 494, Type F or G admixture is used, the slump after the addition of the admixture shall be no less than 6 inches nor greater than 8 inches. Slump tolerances shall comply with the requirements of ACI 117.

f. Chloride Ion Penetration. To ensure the durability of concrete in marine environment, concrete shall be proportioned to have the chloride ion penetration test in accordance with ASTM C 1202, and be below 750 coulombs for concrete specimens tested at 28 days.

2.1.3 Required Average Strength of Concrete

The minimum compressive strength (fcr) of the selected mixture shall equal or exceed the strength required under ACI 301 for laboratory mixture designs and which passes the test indicated in the subparagraph entitled "Chloride Ion Penetration." The average compressive strength produced under field tests shall be the minimum compressive strength (fcr) required during construction.

2.2 MATERIALS

2.2.1 Cement

ASTM C 150, Type I or II and/or ASTM C 595, Type IP(MS) or IS(MS) and ASTM C 1157, Type MS blended cement except as modified herein. The tricalcium aluminate (C3A) content shall not be less than 4 percent to provide protection for the reinforcement and shall not be more than 10 percent to obtain concrete that is resistant to sulfate attack. Blended cements shall consist of a mixture of ASTM C 150 cement and one of the following materials: ASTM C 618 pozzolan or fly ash, or ASTM C 989 ground granulated blast-furnace slag. Use one manufacturer for each type of cement, ground slag, fly ash, and pozzolan.

2.2.1.1 Fly Ash and Pozzolan

ASTM C 618, Type N, F, or C, except that the maximum allowable loss on ignition shall be 6 percent for Types N and F. Add with cement.

2.2.1.2 Ground Iron Blast-Furnace Slag

ASTM C 989, Grade 120.

2.2.1.3 Silica Fume

ASTM C 1240.

2.2.2 Water

Water shall comply with the requirements of ASTM C 94 and the chloride and

sulfate limits in accordance with ASTM D 512 and ASTM D 516. Mixing water shall not contain more than 500 parts per million of chlorides as Cl and not more than 100 parts per million of sulfates as SO_4. Water shall be free from injurious amounts of oils, acids, alkalies, salts, and organic materials. Where water from reprocessed concrete is proposed for use in the work, submit results of tests to verify that the treatment has negated adverse effects of deleterious materials.

2.2.3 Aggregates

ASTM C 33, except as modified herein.

a. The combined aggregates in the mixture (coarse, fine, and blending sizes) shall be well graded from the coarsest to the finest with not more than 18 percent nor less than 8 percent, unless otherwise permitted, of the combined aggregate retained on any individual sieve with the exceptions that the No. 50 may have less than 8 percent retained, sieves finer than No. 50 shall have less than 8 percent retained, and the coarsest sieve may have less than 8 percent retained. Use blending sizes where necessary, to provide a well graded combined aggregate. Reports of individual aggregates shall include standard concrete aggregate sieve sizes including 1 1/2 inches, one inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, and No. 100.

b. Provide aggregates for exposed concrete from one source, ASTM C 227. Do not provide aggregates that react deleteriously with alkalies in cement. Refer to appendix, paragraph entitled "Test Method C227" of ASTM C 33 for expansion limits. Provide aggregate containing no deleterious material properties as identified by ASTM C 295.

c. Where a size designation is indicated, that designation indicates the nominal maximum size of the coarse aggregate.

d. Aggregate may contain materials deleteriously reactive with alkalies in the cement, if cement contains less than 0.60 percent alkalies (percent Na_2O plus .658 percent K_2O). Provide a material such as fly ash, slag, or silica fume as specified to be effective in preventing harmful expansion due to alkali-aggregate reaction by ASTM C 441.

e. Where historical data is used, provide aggregates from the same sources having the same size ranges as those used in the concrete represented by historical data.

f. Marine aggregate may be used when conforming to ASTM C 33 and if it originates from the up-current side of the land mass and it has been washed by the fresh water so that the total chloride and sulfate content of the concrete mixture does not exceed the limits defined herein.

2.2.4 Nonshrink Grout

ASTM C 1107.

2.2.5 Admixtures

a. Provide chemical admixtures that comply with the requirements shown below and in accordance with manufacturer's recommendations, and appropriate for the climatic conditions and the construction needs. Do not use calcium chloride or admixtures containing chlorides from other than impurities from admixture ingredients.

b. Provide minimum concentrations of corrosion-inducing chemicals as shown in Table 2 below. For concrete that may be in contact with prestressing steel tendons, the concentration shall not exceed 60 percent of the limits given in Table 2. For the concentration in grout for prestressing ducts, do not exceed 25 percent of the limits in Table 2.

Table 2 - Limits on Corrosion-Inducing Chemicals

Chemical*	Limits, Percent**	Test Method
Chlorides	0.10	ASTM D 512
Fluorides	0.10	ASTM D 1179
Sulphites	0.13	ASTM D 1339
Nitrates	0.17	ASTM D 3867

* Limits refer to water-soluble chemicals
** Limits are expressed as a percentage of the mass of the total cementitious materials.

c. Provide anti-washout admixtures for underwater placement with a proven record of performance and compatible with the chosen cement.

d. The total alkali content shall not increase the total sodium-oxide equivalent alkali content of the concrete by more than 0.5 lb/yd3.

2.2.5.1 Air Entraining Admixture

Provide air entraining admixtures conforming to ASTM C 260. Provide the admixture of such a type and dosage that the total air content in the hardened concrete can be readily maintained within the limits specified in Table 3.

Table 3 - Air Content

Nominal maximum size of coarse aggregate, inch(es)	Size Number	Total air content, percent by volume
3/8	8	6-10
1/2	7	5-9
3/4	67	4-8
1	57	3.5-6.5
1 1/2	467	3-6
2	357	2.5-5.5
3	-	1.5-4.5

2.2.5.2 Accelerating

ASTM C 494, Type C.

2.2.5.3 Retarding

ASTM C 494, Type B, D, or G.

2.2.5.4 Water Reducing

ASTM C 494, Type A, E, or F.

2.2.5.5 High Range Water Reducer (HRWR)

ASTM C 494, Type F and ASTM C 1017.

2.2.6 Materials for Forms

Provide wood, plywood, or steel. Use plywood or steel forms where a smooth form finish is required. Lumber shall be square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Plywood: PS-1, B-B concrete form panels or better. Steel form surfaces shall not contain irregularities, dents, or sags.

2.2.6.1 Form Ties and Form-Facing Material

a. Provide a form tie system that does not leave mild steel after break-off or removal any closer than 2 inches from the exposed surface. Do not use wire alone. Form ties and accessories shall not reduce the effective cover of the reinforcement.

b. Form-facing material shall be structural plywood or other material that can absorb air trapped in pockets between the form and the concrete and some of the high water-cementitious materials ratio surface paste. Maximum use is three times. Provide forms with a form treatment to prevent bond of the concrete to the form.

c. As an alternate to using an absorptive wood form contact face as a form liner, use "Zendrain" or an approved equal in strict accordance with the manufacturer's recommendations.

2.2.7 Reinforcement

2.2.7.1 Reinforcing Bars

ACI 301 unless otherwise specified. ASTM A 615/A 615M and ASTM A 617/A 617M with the bars marked A, Grade 60; or ASTM A 616/A 616M with the bars marked R, Grade 60. Prefabricated epoxy coated, ASTM A 934/A 934M. Do not use uncoated reinforcing steel.

2.2.7.2 Mechanical Reinforcing Bar Connectors

ACI 301. Provide 125 percent minimum yield strength of the reinforcement bar. Coat connectors in accordance with the same requirements as reinforcing bars.

2.2.7.3 Welded Wire Fabric

ASTM A 185 or ASTM A 497. Provide flat sheets of welded wire fabric for slabs and toppings.

2.2.7.4 Wire

ASTM A 82 or ASTM A 496.

2.2.8 Polyvinylchloride Waterstops

COE CRD-C-572.

2.2.9 Materials for Curing Concrete

2.2.9.1 Impervious Sheeting

ASTM C 171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.2.9.2 Pervious Sheeting

AASHTO M182.

2.2.9.3 Liquid Membrane-Forming Compound

ASTM C 309, white-pigmented, Type 2, Class B.

2.2.10 Liquid Chemical Sealer-Hardener Compound

Provide magnesium fluosilicate compound which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound shall not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.2.11 Expansion/Contraction Joint Filler

ASTM D 1751 or ASTM D 1752, 1/2 inch thick.

2.2.12 Joint Sealants

2.2.12.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D 1190 or ASTM C 920, Type M, Class 25, Use T.

2.2.12.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C 920, Type M, Grade NS, Class 25, Use T.

2.2.13 Epoxy Bonding Compound

ASTM C 881. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.2.14 Dovetail Anchor Slot

Provide preformed metal slot approximately one by one inch minimum 22 gage galvanized steel. Coordinate size and throat opening with dovetail anchors. Provide with removable filler material.

PART 3 EXECUTION

3.1 FORMS

a. ACI 301. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Forms submerged in water shall be watertight.

b. Provide formwork with clean-out openings to permit inspection and removal of debris. Formwork shall be gasketed or otherwise rendered sufficiently tight to prevent leakage of paste or grout under heavy, high-frequency vibration. Use a release agent that does not cause surface dusting. Limit reuse of plywood to no more than three times. Reuse may be further limited by the Contracting Officer if it is found that the pores of the plywood are clogged with paste to the degree that the wood does not absorb the air or the high water-cementitious materials ratio concrete surface.

c. Patch form tie holes with a nonshrink patching material in accordance with the manufacturer's recommendations and subject to approval.

3.1.1 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.1.2 Removal of Forms and Supports

After placing concrete, forms shall remain in place for the time periods specified in ACI 347R, except for concrete placed underwater, forms shall remain in place 48 hours. Prevent concrete damage during form removal.

3.1.2.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if ASTM C 39 test results of field-cured samples from a representative portion of the structure or other approved and calibrated non-destructive testing techniques show that the concrete has reached a minimum of 85 percent of the design strength.

3.1.3 Reshoring

Do not allow construction loads to exceed the superimposed load which the structural member, with necessary supplemental support, is capable of carrying safely and without damage. Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, slabs and beams over 10 feet in span and cantilevers over 4 feet shall be reshored for the remainder of the specified time period in accordance wit paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Reshoring elements shall have the same load-carry capabilities as original shoring and shall be spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.2 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI 301. Remove rust, scale, oil, grease, clay, or foreign substances from reinforcing that would reduce the epoxy coating bond from reinforcing. Do not tack weld. Inspect placed steel reinforcing for coating damage prior to placing concrete. Repair all visible damage.

3.2.1 Epoxy Coated Reinforcing

Shall meet the requirements of ASTM A 934/A 934M including Appendix X2, "Guidelines for Job Site Practices" except as otherwise specified herein.

3.2.1.1 Epoxy Coated Reinforcing Steel Delivery, Handling, and Storage

Record coating lot on each shipping notice and carefully identify and retag bar bundles from bending plant. Provide systems for handling coated bars which have padded contact areas, nylon slings, etc., all free of dirt and grit. Lift bundled coated bars with strong back, multiple supports, or platform bridge to prevent sagging and abrasion. Bundling bands shall be padded where in contact with bars. Do not drop or drag bars or bundles. Store coated bars both in shop and in field, aboveground, on wooden or padded cribbing. Space the dunnage close enough to prevent excessive sags. Stack large quantities of straight bars with adequate protective blocking between layers. Schedule deliveries of epoxy coated bars to the job site to avoid the need for long term storage. Protect from direct sunlight and weather. Bars to be stored longer than 12 hours at the job site shall be covered with opaque polyethylene sheeting or other suitable equivalent protective material.

3.2.1.2 Epoxy Coated Steel Reinforcing Steel Placement and Coating Repair

Carefully handle and install bars to minimize job site patching. Use the same precautions as described above for delivery, handling, and storage when placing coated reinforcement. Do not drag bars over other bars or over abrasive surfaces. Keep bar free of dirt and grit. When possible, assemble reinforcement as tied cages prior to final placement into the forms. Support assembled cages on padded supports. It is not expected that coated bars, when in final position ready for concrete placement, will be completely free of damaged areas; however, excessive nicks and scrapes which expose steel will be cause for rejection. Criteria for defects which require repair and for those that do not require repair are as indicated. Inspect for defects and provide required repairs prior to assembly. After assembly, reinspect and provide final repairs.

a. Immediately prior to application of the patching material, any rust and debonded coating shall be manually removed from the reinforcement by suitable techniques employing devices such as wire brushes and emery paper. Care shall be exercised during this surface preparation so that the damaged areas are not enlarged more than necessary to accomplish the repair. Damaged areas shall be clean of dirt, debris, oil, and similar materials prior to application of the patching material.

b. Repair and patching shall be done in accordance with the patching material manufacturer's recommendations. These recommendations, including cure times, shall be available at the job site at all times.

c. Allow adequate time for the patching materials to cure in accordance with the manufacturer's recommendation prior to concrete placement.

d. Rinse placed reinforcing bars with fresh water to remove chloride contamination prior to placing concrete.

3.2.2 Reinforcement Supports

Place reinforcement and secure with noncorrodible chairs, spacers, or metal hangers. Support reinforcement on the ground with concrete or other noncorrodible material, having a compressive strength equal to or greater than the concrete being placed. For zinc-coated reinforcement, use galvanized supports or supports coated with dielectric material.

ASTM A 934/A 934M. Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable material. Wire bar supports shall be coated with dielectric material, compatible with concrete, for a minimum distance of 2 inches from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars shall be epoxy coated. Spreader bars, where used, shall be epoxy coated. Proprietary combination bar clips and spreaders used in construction with epoxy-coated reinforcing bars shall be made corrosion resistant or coated with dielectric material. Epoxy-coated bars shall be tied with plastic-coated tie wire; or other materials acceptable to the Contracting Officer.

3.2.3 Splicing

As indicated. For splices not indicated, ACI 301. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 2 inches.

3.2.4 Cover

Concrete cover for reinforcement is shown in Table 4. Placement tolerance is plus 1/4 inch. The cover to the principle reinforcing bars shall be not less than 2 times the nominal maximum aggregate size nor less than 1.5 times the effective diameter of the reinforcing bars.

Table 4 - Minimum Concrete Cover Over Reinforcement

Zone	Cover over reinforcing steel	Cover over post-tensioning ducts
Atmospheric zone not subject to salt spray	2.5 in.	3 in.
Tidal, splash, and atmospheric zone subject to salt spray	3.0 in.	3.5 in.
Submerged zone	2.5 in.	3 in.
Cover of stirrups	1/2 in. less than those listed above	-

3.2.5 Setting Miscellaneous Material and Prestress Anchorages

Place and secure anchors, bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete. Electrically isolate exposed steel work and its anchor systems from the primary steel reinforcement with at least 2 inches of concrete. Coat exposed steel work to reduce corrosion. Take particular care to ensure against corrosion on edges and horizontal surfaces. Use epoxy coatings for protection of carbon steel plates and fittings.

3.2.6 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.2.7 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Place contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Sawed joints shall be completed within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.2.8 Waterstop Splices

Fusion weld in the field.

3.2.9 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.3 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C 94, ACI 301, and ACI 304R, except as modified herein. Batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances: 1 per cent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch tickets imprinted with mix identification, batch size, batch design and measured weights, moisture in the aggregates, and time batched for each load of ready mix concrete. When a pozzolan is batched cumulatively with the cement, it shall be batched after the cement has entered the weight hopper.

3.3.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

Adjust batch proportions to replicate the mixture design using methods provided in the approved quality assurance plan. Base the adjustments on results of tests of materials at the batch plant for use in the work. Maintain a full record of adjustments and the basis for each.

3.3.2 Mixing

ASTM C 94 and ACI 301. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 85 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, if both the specified maximum slump and water-cementitious material ratio are not exceeded. When water is added, an additional 30 revolutions of the mixer at mixing speed is required. If time of discharge exceeds time required by ASTM C 94, submit a request along with description of precautions to be taken. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.3.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.4 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other or lifts for vertical construction. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

3.4.1 Vibration

Comply with the requirements of ACI 309R and ASTM A 934/A 934M using vibrators with a minimum frequency of 9000 vibrations per minute (VPM). Use only high cycle or high frequency vibrators. Motor-in-head 60 cycle vibrators may not be used. For walls and deep beams, use a minimum of two vibrators with the first to melt down the mixture and the second to thoroughly consolidate the mass. Provide a spare vibrator at the casting site whenever concrete is placed. Place concrete in 18 inch maximum vertical lifts. Insert and withdraw vibrators approximately 18 inches apart. Penetrate at least 8 inches into the previously placed lift with the vibrator when more than one lift is required. Extract the vibrator using a series of up and down motions to drive the trapped air out of the concrete and from between the concrete and the forms.

For slab construction use vibrating screeds designed to consolidate the full depth of the concrete. Where beams and slabs intersect, use an internal vibrator to consolidate the beam. Do not vibrate concrete placed with anti-washout admixtures. Vibrators shall be equipped with rubber

vibrator heads.

3.4.2 Application of Epoxy Bonding Compound

Apply a thin coat of compound to dry, clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is tacky. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.4.3 Pumping

ACI 304R and ACI 304.2R. Pumping shall not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment shall not exceed 2 inches. Do not use pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of coarse aggregate to 33 percent of the diameter of the pipe. Maximum size of well rounded aggregate shall be limited to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.4.4 Cold Weather

ACI 306.1. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 5 degrees F in any one hour and 50 degrees F per 24 hours after heat application.

3.4.5 Hot Weather

ACI 305R. Maintain required concrete temperature using Figure 2.1.5, "Effect of Concrete Temperatures, Relative Humidity, and Wind Velocity on the Rate of Evaporation of Surface Moisture From Concrete" in ACI 305R to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.5 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT

3.5.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than one square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete

with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete shall not vary more than the allowable tolerances of ACI 347R. Exposed surfaces shall be uniform in appearance and finished to a smooth form finish unless otherwise indicated.

3.5.2 Formed Surfaces

3.5.2.1 Tolerances

ACI 117 and as indicated.

3.5.2.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 0.25 inch in height.

3.5.2.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Patch tie holes and defects and completely remove fins.

3.6 FINISHES FOR HORIZONTAL CONCRETE SURFACES

3.6.1 Finish

ACI 301. Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.6.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. After the concrete has been placed, consolidated, struck off, and leveled, the surface shall be roughened with stiff brushes of rakes before final set.

3.6.1.2 Floated

After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further, until ready for floating. Whether floating with a wood, magnesium, or composite hand float, with a bladed power trowel equipped with float shoes, or with a powered disc, float shall begin when the surface has stiffened sufficiently to permit the operation.

3.6.1.3 Concrete Containing Silica Fume

Finish using magnesium floats or darbies.

3.6.1.4 Broomed

Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.6.1.5 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as necessary. Obtain final finish by a burlap drag. Drag a strip of clean, wet burlap from 3 to 10 feet wide and 2 feet longer than the pavement width across the slab . Produce a fine, granular, sandy textured surface without disfiguring marks. Round edges and joints with an edger having a radius of 1/8 inch.

3.6.1.6 Concrete Toppings Placement

ACI 301. The following requirements apply to the placement of toppings of concrete on concrete surfaces that are either freshly placed and still plastic, or on hardened base slabs.

a. Placing on a Fresh Concrete: Screed and bull float the base slab. As soon as water sheen has disappeared, lightly rake surface of the base slab with a stiff bristle broom to produce a bonding surface for the topping. Immediately spread topping mixture evenly over the roughened base before final set takes place. Give topping the finish specified.

b. Bonding to a Hardened Concrete: When the topping is to be bonded to a floated or troweled hardened base, roughen the base by scarifying, grit-blasting, scabbling, planing, flame cleaning, or acid-etching to lightly expose aggregate and provide a bonding surface. Remove dirt, laitance, and loose aggregate by means of a stiff wire broom. Keep the clean base wet for a period of 12 hours preceding the application of the topping. Remove excess water and apply a 1:1:1/2 cement-sand-water grout, and brush into the surface of the base slab. Do not allow the cement grout to dry, and spread it only short distances a head of the topping placement. Do not allow the temperature differential between the completed base and the topping mixture to exceed 10 degrees F at the time of placing. Place the topping and finish as specified herein.

3.7 CURING AND PROTECTION

a. ACI 301 and ACI 308 unless otherwise specified. Prevent concrete from drying by misting surface of concrete. Begin curing immediately following final set. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, by rain or running water, adverse weather conditions, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow

concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete , or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating.

b. Wet cure marine concrete using potable water for a minimum of 7 days. Do not allow construction loads to exceed the superimposed load which the structural member, with necessary supplemental support, is capable of carrying safely and without damage.

3.7.1 Moist Curing

Remove water without erosion or damage to the structure.

3.7.1.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water shall not be 20 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.7.1.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.7.1.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6 inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.7.1.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.7.2 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen

which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2 .1.5, "effect of Concrete Temperatures, Relative Humidity, and Wind Velocity on the Rate of Evaporation of Surface Moisture From Concrete" in ACI 305R indicates that hot weather conditions will cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.

3.7.2.1 Application

Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats shall be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Respray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.7.2.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.7.3 Liquid Chemical Sealer-Hardener

Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener shall not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.7.4 Curing Periods

Moist cure concrete using potable water for a minimum of 7 days. Continue additional curing for a total period of 21 days. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be subject to approval by the Contracting Officer.

3.7.5 Requirements for Type III, High-Early-Strength Portland Cement

The curing periods shall be not less than one-fourth of those specified for portland cement, but in no case less than 72 hours.

3.8 FIELD QUALITY CONTROL

3.8.1 Evaluation of Mixture Designs

a. The adequacy of the mixture design to produce the minimum specified strength and durability shall be confirmed by testing field batches, casting concrete in a slab and a wall at the job using job materials, equipment, and personnel, and testing the hardened concrete as described herein. The slab shall be at least 8 feet

square and have thickness of at least 8 inches. The wall shall be 8 feet long, 4 feet high, and at least 8 inches thick. Slump shall not exceed the slump proposed for the work. Water cure the castings for 7 days.

b. Test the fresh concrete as follows:

(1) Slump in accordance with ASTM C 143.

(2) Air content in accordance with ASTM C 231 or ASTM C 173.

(3) Unit weight in accordance with ASTM C 138.

(4) For strength, cast nineteen 6 by 12 inchcylinders in accordance with ASTM C 31/C 31M.

c. Test 6 by 12 inch cylinders cast under subparagraph b above as follows:

(1) Measure and weigh each specimen to determine unit weight as they are stripped from the molds.

(2) Test specimens to be tested at each age for pulse velocity through concrete in accordance with ASTM C 597.

(3) Two at each age of 24 hours and 3 and 7 days in accordance with ASTM C 39.

(4) Three at each age of 28, 56, and 90 days in accordance with ASTM C 39</ RID>.

(5) Two at each age of 28 and 90 days in accordance with ASTM C 496.

d. Take twenty-five 4-inch cores from each the wall and the slab in accordance with ASTM C 42. Those to be tested at 7 days or earlier age shall be drilled on the test date and tested as cored. Those to be tested at later ages shall be drilled in adequate time for wet curing before testing. Test cores as follows:

(1) All cores: Pulse velocity through concrete in accordance with ASTM C 597.

(2) Two cores: Static modulus of elasticity in accordance with ASTM C 469 at age 28 days.

(3) Two cores: Specific gravity, absorption, and voids in concrete in accordance with ASTM C 642.

(4) Three cores: Resistance to chloride ion penetration in accordance with ASTM C 1202 at ages 28 and 90 days.

(5) Compressive strength in accordance with ASTM C 39.

two cores at 24 hours
one core at 3 days
two cores at 7 days
three cores at 28 days
two cores at 90 days
three spare cores

e. Sampling and determination of water soluble chloride ion content in accordance with ASTM C 1218/C 1218M. Maximum water soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the limits of Table 5 below.

Table 5 - Maximum Chloride Ion Content for Corrosion Protection

Type of Member	Maximum water soluble chloride ion (Cl) in concrete, percent by weight of cement
Prestressed concrete	0.06
Reinforced concrete exposed to chloride in service	0.08
Reinforced concrete that will be dry or protected from moisture in service	0.15
Other reinforced concrete construction	0.30

f. Submit test results for evaluation and acceptance.

3.8.2 Sampling

a. ASTM C 172. Collect samples of fresh concrete to perform tests specified. ASTM C 31/C 31M for making test specimens.

b. Sample concrete on a random basis except where a batch appears to be deficient and the test can be used to verify the observed deviation. Identify samples so taken in a manner that they can be segmented from other tests. Obtain at least one sample for each 100 cubic yards, or fraction thereof, of each design mixture of concrete placed in any one day. When the total quantity of concrete with a given design mixture is less than 50 cubic yards, the strength tests may be waived by the Contracting Officer, if in his judgment, adequate evidence of satisfactory strength is provided.

3.8.3 Testing

3.8.3.1 Slump Tests

ASTM C 143. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved high range water reducing (HRWR)` admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 10 cubic yards (maximum) of concrete.

3.8.3.2 Temperature Tests

a. Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions below 50 degrees F and above 80 degrees F for each batch (minimum) or every 10 cubic yards

(maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

b. Determine temperature of each composite sample in accordance with ASTM C 1064. When the average of the highest and lowest temperature during the period from midnight to midnight is expected to drop below 40 degree s F for more than 3 successive days, concrete shall be delivered to meet the following minimum temperature at the time of placement:

(1) 55 degrees F for sections less than 12 inches in the least dimension

(2) 50 degrees F for sections 12 to 36 inches in the least dimension

(3) 45 degrees F for sections 36 to 72 inches in the least dimension

(4) 40 degrees F for sections greater than 72 inches in the least dimension

c. The minimum requirements may be terminated when temperatures above 50 degrees F occur during more than half of any 24 hour duration. The temperature of concrete at time of placement shall not exceed 90 degrees F.

3.8.3.3 Compressive Strength Tests

ACI 214 tests for strength - conduct strength tests of concrete during construction in accordance with the following procedures:

a. Mold and cure six 6 by 12 inch cylinders from each sample taken in accordance with ASTM C 31/C 31M. Prevent evaporation an d loss of water from the specimen.

b. Test cylinders in accordance with ASTM C 39. Test one cylinder at 3 days, two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. The compressive strength test results for acceptance shall be the average of the compressive strengths from the two specimens tested at 28 days. If one specimen in a test shows evidence of improper sampling, molding or testing, discard the specimen and consider the strength of the remaining cylinder to be the test result. If both specimens in a test show any defects, the Contracting Officer may allow the entire test to be discarded.

c. If the average of any three consecutive strength test results is less than the specified strength (f'c) or the minimum test strength (fcr) for durability, whichever is higher, by more the 500 psi, take a minimum of three core samples in accordance with ASTM C 42, from the in-place work represented by the low test results. Locations represented by erratic core strengths shall be retested. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

d. Strength test reports shall include location in the work where the batch represented by a test was deposited, batch ticket number, time batched and sampled, slump, air content (where specified),

mixture and ambient temperature, unit weight, and water added on the job. Reports of strength tests shall include detailed information of storage and curing of specimens prior to testing.

e. Final reports shall be provided within 7 days of test completion.

3.8.3.4 Air Content

ASTM C 173 o r ASTM C 231 for normal weight concrete. Where concrete will be exposed to deicing salts as indicated. Make air content tests on samples from the first three batches in the placement and until three consecutive batches have air contents within the range of the specified air content, at which time test every fifth batch. Maintain this test frequency until a batch is not within the specified range at which time resume testing of each batch until three consecutive batches have air contents within the specified range. Perform additional tests as necessary for control. Take air content tests from planned composite samples or from samples taken in accordance with ASTM C 172 at the point of concrete placement.

3.8.3.5 Chloride Ion Concentration

ACI 318/318M. Determine water soluble chloride ion concentration. Perform test once for each mix design.

3.8.3.6 Anti-Washout Admixture

COE CRD-C-61. Determine cumulative mass loss. Perform test once for each 350 cubic yards of underwater concrete.

3.8.4 Non-Destructive Tests

Non-destructive tests - use of the rebound hammer in accordance with ASTM C 805, ASTM C 597, or other non-destructive processes may be permitted by the Contracting Officer in evaluating the uniformity and relative concrete strength in place, or for selecting areas to be cored.

Evaluate and validate test results conducted on properly calibrated equipment in accordance with standard ASTM procedures indicated

3.8.4.1 Core Tests

Obtain and test cores in accordance with ASTM C 42. If concrete in the structure is dry under service conditions, air dry cores (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for 7 days before testing and test dry. If concrete in the structure will be more than superficially wet under service conditions, test the cores, after moisture conditioning, in accordance with ASTM C 42.

Take at least three representative cores from each member or area of concrete in place that is considered potentially deficient. Impair the strength of the structure as little as possible. If, before testing, cores show evidence of having been damaged subsequent to or during removal from the structure, take replacement cores.

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

The Contracting Office will evaluate and validate core tests in accordance

with the specified procedures. Before testing in compression, test each core to determine pulse velocity through concrete in accordance with ASTM C 597. Correlate pulse velocity of concrete cores with pulse velocity of in-place concrete.

3.8.5 Acceptance of Concrete Strength

3.8.5.1 Standard Molded and Cured Strength Specimens

When the averages of all sets of three consecutive compressive strength test results equal or exceed the design compressive strength (f'c) or the required field test strength (fcr) whichever is higher, and no individual strength test falls below the specified compressive strength (f'c) or the required field durability strength (fcr) by more than 500 psi, whichever is higher. These criteria also apply when accelerated strength testing is specified unless another basis for acceptance is specified.

3.8.5.2 Non-Destructive Tests

Non-destructive tests may be used when permitted to evaluate concrete where standard molded and cured cylinders have yielded results not meeting the criteria.

3.8.5.3 Core Tests

When the average compressive strengths of the representative cores are equal to at least 85 percent of the design strength (f'c) or the required average test strength (fcr), whichever is higher, and if no single core is less than 75 percent of t he specified strength (f'c) or the required average field test strength (fcr), whichever is higher, strength of concrete is satisfactory.

3.8.6 Inspection

ACI 311.1R. Inspect concrete placed under water with qualified engineer/divers.

-- End of Section --

SECTION 05090A

WELDING, STRUCTURAL

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC ASD Spec S335	(1989) Specification for Structural Steel Buildings - Allowable Stress Design, Plastic Design

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT RP SNT-TC-1A	(1996) Recommended Practice SNT-TC-1A

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1998) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0	(1994) Standard Welding Terms and Definitions
AWS D1.1	(1998) Structural Welding Code - Steel
AWS Z49.1	(1999) Safety in Welding and Cutting and Allied Processes

1.2 DEFINITIONS

Definitions of welding terms shall be in accordance with AWS A3.0.

1.3 GENERAL REQUIREMENTS

The design of welded connections shall conform to AISC ASD Spec S335 unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Welding shall be as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Welding shall not be started until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Qualification testing shall be performed at or near the work site. Each Contractor performing welding shall maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

1.3.1 Pre-erection Conference

A pre-erection conference shall be held, prior to the start of the field welding, to bring all affected parties together and to gain a naturally clear understanding of the project and the Welding Procedure Specifications (WPS) (which the Contractor shall develop and submit for all welding, including welding done using prequalified procedures). Attendees shall include all Contractor's welding production and inspection personnel and appropriate Government personnel. Items for discussion could include: responsibilities of various parties; welding procedures and processes to be followed; welding sequence (both within a joint and joint sequence within the building); inspection requirements and procedures, both visual and ultrasonic; welding schedule; fabrication of mock-up model; and other items deemed necessary by the attendees.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Welding Procedure Qualifications; G
Welder, Welding Operator, and Tacker Qualification; G
Inspector Qualification; G
Previous Qualifications; G
Prequalified Procedures; G

Copies of the welding procedure specifications; the procedure qualification test records; and the welder, welding operator, or tacker qualification test records.

A quality assurance plan and records of tests and inspections.

1.5 WELDING PROCEDURE QUALIFICATIONS

Except for prequalified per AWS D1.1 and previously qualified procedures, each Contractor performing welding shall record in detail and shall qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Qualification of welding procedures shall conform to AWS D1.1 and to the specifications in this section. Copies of the welding procedure specification and the results of the procedure qualification test for each type of welding which requires procedure qualification shall be submitted for approval. Approval of any procedure, however, will not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the requirements of these specifications. This information shall be submitted on the forms in Appendix E of AWS D1.1. Welding procedure specifications shall be individually identified and shall be referenced on the detail drawings and erection drawings, or shall be suitably keyed to the contract drawings. In case of conflict between this specification and AWS D1.1, this specification governs.

1.5.1 Previous Qualifications

Welding procedures previously qualified by test may be accepted for this contract without requalification if the following conditions are met:

a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.5.2 Prequalified Procedures

Welding procedures which are considered prequalified as specified in AWS D1.1 will be accepted without further qualification. The Contractor shall submit for approval a listing or an annotated drawing to indicate the joints not prequalified. Procedure qualification shall be required for these joints.

1.5.3 Retests

If welding procedure fails to meet the requirements of AWS D1.1, the procedure specification shall be revised and requalified, or at the Contractor's option, welding procedure may be retested in accordance with AWS D1.1. If the welding procedure is qualified through retesting, all test results, including those of test welds that failed to meet the requirements, shall be submitted with the welding procedure.

1.6 WELDER, WELDING OPERATOR, AND TACKER QUALIFICATION

Each welder, welding operator, and tacker assigned to work on this contract shall be qualified in accordance with the applicable requirements of AWS D1.1 and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used.

1.6.1 Previous Personnel Qualifications

At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without requalification if all the following conditions are met:

a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.

b. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.

c. The previously qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.

d. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

1.6.2 Certificates

Before assigning any welder, welding operator, or tacker to work under this contract, the Contractor shall submit the names of the welders, welding operators, and tackers to be employed, and certification that each individual is qualified as specified. The certification shall state the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests. The certification shall be kept on file, and 3 copies shall be furnished. The certification shall be kept current for the duration of the contract.

1.6.3 Renewal of Qualification

Requalification of a welder or welding operator shall be required under any of the following conditions:

a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.

b. There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.

c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified shall be submitted as evidence of conformance.

d. A tacker who passes the qualification test shall be considered eligible to perform tack welding indefinitely in the positions and with the processes for which he is qualified, unless there is some specific reason to question the tacker's ability. In such a case, the tacker shall be required to pass the prescribed tack welding test.

1.7 INSPECTOR QUALIFICATION

Inspector qualifications shall be in accordance with AWS D1.1. Nondestructive testing personnel shall be qualified in accordance with the requirements of ASNT RP SNT-TC-1A for Levels I or II in the applicable nondestructive testing method. The inspector may be supported by assistant welding inspectors who are not qualified to ASNT RP SNT-TC-1A, and assistant inspectors may perform specific inspection functions under the supervision of the qualified inspector.

1.8 SYMBOLS

Symbols shall be in accordance with AWS A2.4, unless otherwise indicated.

1.9 SAFETY

Safety precautions during welding shall conform to AWS Z49.1.

PART 2 PRODUCTS

2.1 WELDING EQUIPMENT AND MATERIALS

All welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator performing qualified welding procedures. All welding equipment and materials shall comply with the applicable requirements of AWS D1.1.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

3.1.1 Requirements

Workmanship and techniques for welded construction shall conform to the requirements of AWS D1.1 and AISC ASD Spec S335. When AWS D1.1 and the AISC ASD Spec S335 specification conflict, the requirements of AWS D1.1 shall govern.

3.2 QUALITY CONTROL

Testing shall be done by an approved inspection or testing laboratory or technical consultant; or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. The Contractor shall perform visual inspection to determine conformance with paragraph STANDARDS OF ACCEPTANCE. Procedures and techniques for inspection shall be in accordance with applicable requirements of AWS D1.1, except that in radiographic inspection only film types designated as "fine grain," or "extra fine," shall be employed.

3.3 STANDARDS OF ACCEPTANCE

Dimensional tolerances for welded construction, details of welds, and quality of welds shall be in accordance with the applicable requirements of AWS D1.1 and the contract drawings. Nondestructive testing shall be by visual inspection methods. The minimum extent of nondestructive testing shall be random 20 percent of welds or joints, as indicated on the drawings.

3.3.1 Nondestructive Examination

The welding shall be subject to inspection and tests in the mill, shop, and field. Inspection and tests in the mill or shop will not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment.

3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The costs of such inspection and testing will be borne by the Contractor if unsatisfactory welds are discovered, or by the Government if the welds are satisfactory. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive

tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

3.5 CORRECTIONS AND REPAIRS

When inspection or testing indicates defects in the weld joints, the welds shall be repaired using a qualified welder or welding operator as applicable. Corrections shall be in accordance with the requirements of AWS D1.1 and the specifications. Defects shall be repaired in accordance with the approved procedures. Defects discovered between passes shall be repaired before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, the affected area shall be blended into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before rewelding, the area shall be examined by suitable methods to ensure that the defect has been eliminated. Repair welds shall meet the inspection requirements for the original welds. Any indication of a defect shall be regarded as a defect, unless reevaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

-- End of Section --

SECTION 05120N

STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC M013	(1983) Detailing for Steel Construction
AISC M016	(1989) ASD Manual of Steel Construction
AISC M017	(1992; Errata 1994) Connections
AISC S335	(1989) Structural Steel Buildings Allowable Stress Design and Plastic Design

ASME INTERNATIONAL (ASME)

ANSI/ASME B46.1	(1995) Surface Texture, (Surface Roughness, Waviness, and Lay)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A36/A36M	(1997; Rev. A) Carbon Structural Steel
ASTM A53	(1999; Rev. B) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A500	(1998) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM C827	(1995; R 1997) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
ASTM C1107	(1999) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-P-664	(Rev. D) Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-P-24441	(Rev. B; Supp. 1) Paint, Epoxy-Polyamide

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC PA 1	(1991) Shop, Field, and Maintenance Painting

1.2 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer , complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC M016 and AISC M017 except as modified in this contract.

1.3 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Fabrication drawings; G

SD-03 Product Data

Shop primer

Load indicator washers

Load indicator bolts

SD-06 Test Reports

Class B coating

Bolts, nuts, and washers (Stainless Steel T-316)

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

SD-07 Certificates

Steel

Bolts, nuts, and washers (Stainless Steel T-316)

Shop primer

Welding electrodes and rods

Nonshrink grout

Erection plan

Welding procedures and qualifications

1.4 QUALITY ASSURANCE

1.4.1 Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC M013, AISC M016 and AISC M017. Drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS standard welding symbols. Shoring and temporary bracing shall be designed and sealed by a registered professional engineer and submitted for record purposes as part of the drawings.

1.4.2 Certifications

1.4.2.1 Erection Plan

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

1.4.2.2 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

PART 2 PRODUCTS

2.1 STEEL

2.1.1 Structural Steel

ASTM A36/A36M.

2.1.2 Structural Steel Tubing

ASTM A500, Grade B .

2.1.3 Steel Pipe

ASTM A53, Type E or S, Grade B, weight class XS.

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel

2.2.1.1 Bolts

Stainless Steel T-316. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.2.1.2 Nuts

Stainless Steel T-316.

2.2.1.3 Washers

Stainless Steel T-316.

2.2.2 Foundation Anchorage

2.2.2.1 Bolts

Stainless Steel T-316.

2.2.2.2 Nuts

Stainless Steel T-316.

2.2.2.3 Washers

Stainless Steel T-316..

2.2.3 Load Indicator Washers

Stainless Steel T-316.

2.2.4 Load Indicator Bolts

Stainless Steel T-316. The bolt shall be designed to react to the opposing rotational torques applied by the installation wrench, with the bolt tip automatically shearing off when the proper tension is obtained.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Welding Electrodes and Rods

AWS D1.1.

2.3.2 Nonshrink Grout

ASTM C1107, with no ASTM C827 shrinkage.

2.4 SHOP PRIMER

FS TT-P-664, SSPC Paint 25, or MIL-P-24441/1 epoxy-polyamide, green primer (Form 150) type 1, except provide a Class B coating in accordance with AISC M016 and AISC M017 for slip critical joints. Primer shall conform to Federal, State, and local VOC regulations. If flash rusting occurs, re-clean the surface prior to application of primer.

2.5 FABRICATION

2.5.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations.

2.5.2 Shop Primer

Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, surfaces to receive epoxy coatings, surfaces within 0.5 inch of the toe of the welds prior to welding. Slip critical surfaces shall be primed with a Class B coating. Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer.

2.5.2.1 Cleaning

Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

2.5.2.2 Primer

Apply primer to a minimum dry film thickness of 2.0 mil except provide the Class B coating for slip critical joints in accordance with the coating manufacturer's recommendations. Repair damaged primed surfaces with an additional coat of primer.

2.5.3 Epoxy Coated Surfaces

Surfaces to receive epoxy coatings shall be cleaned and prepared in accordance with the manufacturer's recommendations.

2.5.4 Surface Finishes

ANSI/ASME B46.1 maximum surface roughness of 125 for pin, and pinholes unless indicated otherwise.

PART 3 EXECUTION

3.1 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with AISC S335 . Do not tighten anchor bolts set in concrete with impact torque wrenches. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

3.2 WELDING

AWS D1.1. Provide AWS D1.1 qualified welders, welding operators, and tackers.

3.2.1 Removal of Temporary Welds

Removal is not required.

3.3 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.4 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

3.4.1 Welds

3.4.1.1 Visual Inspection

AWS D1.1. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark welds, including fillet weld end returns.

3.4.1.2 Nondestructive Testing

AWS D1.1. Test locations shall be selected by the Contracting Officer. If more than 20 percent of welds made by a welder contain defects identified by testing, then all welds made by that welder shall be tested by radiographic or ultrasonic testing, as approved by the Contracting Officer. When all welds made by an individual welder are required to be tested, magnetic particle testing shall be used only in areas inaccessible to either radiographic or ultrasonic testing. Retest defective areas after repair.

-- End of Section --

SECTION 11286A

HEAVY DUTY TITESEAL COPOLYMER SLUICE GATE

PART 1 GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Heavy duty titeseal copolymer sluice gate; G;

Submit as necessary to install sluice gate.

SD-03

Heavy duty titeseal copolymer sluice gate materials

Submit sufficient data indicating conformance to specified requirements on materials provided under this section.

SD-05 Design Data

Sluice gate; G

Anchor bolt loads; G

SD-06 Test Reports

Laminate

SD-07 Certificates

Heavy duty titeseal copolymer sluice gate materials

Submit certificates attesting that materials comply with this specification.

SD-08 Operations and Maintenance Data

Heavy duty titeseal copolymer sluice gate, data package; G

Submit operation and maintenance data in accordance with Section 01781, "OPERATION AND MAINTENANCE DATA".

1.2 DELIVERY, STORAGE, ADN HANDLINGSUBMITTALS

Deliver, store, and handle manufactured items so that materials remain dry and undamaged.

1.3 WARRANTY

Provide warranty against defects arising out of or caused by ordinary wear

and tear by the elements for a period of 20 years. Such warranty shall start upon final acceptance of the work or the date the Government takes possession, whichever is earlier.

PART 2 PRODUCTS

2.1 SLUICE GATE

The contractor shall furnish and install a heavy duty sluice gate and Operator. Gate and operator shall be furnished complete with all necessary parts and accessories; and shall be fabricated, assembled and placed in proper operating condition in accordance with the plans and specifications, and in full conformity with installation instructions and recommendations of the equipment manufacturer. Equipment shall be the latest product design of a manufacturer regularly engaged in the production of equipment of this type.

The contractor shall submit detailed drawings of the proposed equipment, and suitable evidence of experience of the manufacturer and results to the engineer.

2.1.1 Gate Laminate

Composition of the gate laminate shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermostat Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship the Society of the Plastics Industry, Inc. (SPI) and the Material Technology Institute of the Chemical Process Industries, Inc. (MTI) for "Hand Lay-up Laminates" and shall meet the specifications for Type 1, Grade 10 laminates shown in Appendix M-1 of said report.

2.1.2 Assemblies

Sluice gate assemblies will be designed so that the maximum fiber stress (ultimate or yield whichever applies) does not exceed 2.5 times the working stress. Gates shall be suitably reinforced to withstand the maximum seating head with a deflection of less than 1/4". Warpage throughout the entire gate shall not produce a crown of more than 1/16" in any direction.

2.2 DEFECTS

Visual inspection for defects shall be made without the aid of magnification and defects shall be classified as to type and level as shown in Table 1 of ANSI/ASTM D2563-0, approved 1977, (or any subsequent revision). Allowable surface tolerances are as follows:

DEFECTS	ALLOWABLE TOLERANCE
Crack, Crazing, Blisters, Chips, Pits, Dry Spots, Fish Eyes, Burned Areas or Entrapped Air	None
Wrinkles and solid blisters of thickness, not to exceed 1/8"	Maximum Deviation: 10%
Surface porosity (pinholes or pores in the laminiate surface	None

DEFECTS	ALLOWABLE TOLERANCE
Exposed Glass, Exposure of cut edges	None
Scratches - deep	None more than .002"
Foreign Matter	None

2.3 LEAKAGE

Maximum allowable leakage of sluice gates with seating head shall not exceed 0.10 gpm/ft of wetted perimeter, or 0.20 gpm/ft of wetted perimeter for gates with unseating head at the maximum seating pressure specified.

PART 3 EXECUTION

3.1 MATERIALS

3.1.1 Head Frames, Guides, and Operator Support Yoke

Type T-316 Stainless Steel/Fiberglass Reinforced Polyester.

3.1.2 Gates

Fiberglass Reinforced Polyester (FRP) totally encapsulating an internal reinforcing structure. Structural characteristics for an 1/8" glass mat laminate shall meet the following minimum physical properties.

Tensile Strength	17,900 psi
Flexural Modulus	800,000 - 900,000 psi
Flexural Strength	27,600 psi
Compressive Strength	22,000 psi
Impact Strength	9.0 ft-lbs/in.
Water Absorption	0.13% (in 24 hours)

3.1.3 Stems and Gate Hardware

T-316 Stainless Steel.

3.1.4 Closure Seals

3.1.4.1 Hollow Bulb J-Seals and Bottom Wedge Seal

Molded of extruded virgin neoprene with vulcanized corners per ASTM D-2000. The following physical characteristics apply:

Specific Gravity	1.25
Hardness	55 -65 Shore A Durometer
Tensile Strength	15,000 psi min.
Elongation	300%
Low Temperature Brittleness	-40 deg F

3.1.4.2 J-Seal Clamping Bars and Fasteners

T-316 Stainless Steel/FRP.

3.1.4.3 Wear Strips

UHMW polyethylene. Physical properties are:

Tensile Strength	5,600 psi
Water Absorption	0.01% (in 24 hours)
Flexural Modulus (@ 73 deg F)	130,000 - 140,000 psi
Coefficient of Friction	0.15

3.2 MANUAL OPERATORS

3.2.1 Lift Nuts and Thrust Nuts

Manganese Bronze, ASTM B-584, Alloy 865.

3.2.2 Thrust Collar

Cast iron, ASTM A-126 Class B.

3.2.3 Handwheel

Cast iron, ASTM A-126 Class B.

3.2.4 Anchor Bolts

T-316 Stainless Steel.

3.3 CONSTRUCTION

The sluice gate cover shall be manufactured of fiberglass reinforced polyester totally encapsulating an internal reinforcing structure. To assure maximum service life, the copolymer composite shall be ultraviolet stabilized and seamless to protect inner structural members from corrosion caused by exposure to water or corrosive chemicals. Sluice gates shall be furnished complete with frames, slides, J-seals, UHMW wear strip, operating stems, operators, and necessary appurtenances.

3.4 GATES

Each gate shall be molded individually to the exact dimensions specified. Sluice gates shall be manufactured of reinforced thermoset plastic containing ultraviolet absorbers. The surface shall be resin rich to a depth of .010 inches to .020 inches and reinforced with C-glass or polymeric fiber surfacing material. The surface shall be free of exposed reinforcing fibers. The composition of these layers shall be approximately 95% (by weight)resin.

The remaining laminate shall be made up of copolymer composite and reinforcing fibers in a form, orientation and position to meet the mechanical requirements. Structural reinforcing shall be utilized to attain the necessary stiffness to meet deflection requirements, and shall be well encapsulated with a laminate not less than 1/4" thick on each side

to insure against any permeation by water to the core areas. A Type-316 stainless steel stem mounting bracket shall fasten to the gate with through bolts. The through holes shall not pass through or in contact with the internal steel reinforcing. Core material must be 100% resistant to decay and attack by fungus and bacteria and be resistant to hydrocarbons.

3.5 SEALS

The gate shall be equipped with elastomeric seals to reduce leakage. At the maximum operating head the leakage shall not exceed 0.1 GPM per foot of wetted perimeter.

Elastomeric J-seals shall be made of molded or extruded neoprene having a hardness range of 55 to 65 shore A durometer and conforming to ASTM D-2000 having a maximum compression set of 25%, and low temperature brittleness to meet suffix F-17 (-40 F). Seals, including bottom seals, shall be mounted on gate covers with T-304 stainless steel capscrews and T-304 stainless steel or FRP clamping bars thus providing a means of repair, and replacement without dewatering the channel. A 1/4" thick UHMW wear strip will be fastened to the opposite side of the gate from the J-seals along both sides, and shall have a coefficient of friction less than 0.15.

3.6 FRAMES AND GUIDES

Guides shall be styled for wall mounting. Guides shall be fabricated from Type T-316 stainless steel/FRP and shall have a slot suitable for mating with the gate cover. Guides to be bolted to the head wall shall be equipped with heavy duty slotted clips for ease of mounting to the channel wall by means of T-316 stainless steel anchors. Where the guides are extended above the operating floor level to form the bench stand upon which the lift mechanism is fastened, they must be suitably strong and rigid without the use of additional stiffening members. The head rail shall also be of T-316 stainless steel/FRP and shall be affixed so as to allow the gate to be removed from the guide without disassembly.

-- End of Section --

SECTION 11289

DOWNWARD OPENING FRP WEIR GATES

PART 1 GENERAL

Under this section of the specification the contractor shall furnish and install Downward Opening Weir Gate(s) and Operator(s) as manufactured by Plasti-Fab, Inc., P. O. Box 100, Tualatin, Oregon 97062, or approved equal. Gate(s) and operator(s) shall be furnished complete with all necessary parts and accessories; and shall be fabricated, assembled and placed in proper operating condition in accordance with installation instructions and recommendations of the equipment manufacturer. Equipment shall be the latest product design of a manufacturer regularly engaged in the production of equipment of this type.

PART 2 PRODUCTS

2.1 DESIGN CRITERIA

2.1.1 Workmanship

Composition of the slide gate laminate shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship of the Society of the Plastics Industry, Inc. (SPI), and the Material Technology Institute (MTI) of the Chemical Process Industry for "Hand Lay-up Laminates," and shall meet the specifications for Type I, Grade 10 laminates shown in Appendix M-1 of said report.

2.1.1.1 Design

Gate assemblies will be designed so that the maximum fiber stress (ultimate or yield, whichever applies) does not exceed 2.5 times the working stress. Gates shall be suitably reinforced to withstand the maximum head with a deflection at the maximum operating head of less than 1/360 of the gate width, or 1/4 inch, whichever is less. Gates with unseating heads shall be designed for a maximum deflection of 1/16 inch.

All gates shall be of fiberglass-reinforced polyester (FRP) with a UV stabilizer. Gates shall be flat and level. Warpage throughout the entire gate shall not produce a crown of more than 1/16 inch in any direction. Visual inspection for defects shall be made without the aid of magnification. Defects shall be classified as to type and level as shown in TABLE I of ANSI/ASTM D2563-0, approved 1997, or any subsequent revision.

Allowable surface tolerances shall not exceed the following:

DEFECT	ALLOWABLE TOLERANCE
Cracks, crazing, chips, pits, blisters, dry spots, fish eyes, burned areas or entrapped air	None
Scratches	None more than 0.002 inches

DEFECT	ALLOWABLE TOLERANCE in depth
Exposed glass, exposure of cut edges	None
Wrinkle and solid blisters	Maximum deviation: 10% of thickness but not to exceed 1/8 inch
Surface porosity (pinholes or pores in the laminate surface	None
Foreign Matter	None

2.2 MATERIALS

2.2.1 Head Frames, Guides, Reinforcing Members, Operator Support Yoke

Pultruded reinforced polyester (FRP). Structural characteristics in the longitudinal direction shall meet the following physical properties:

Tensile strength	30,000 psi
Flexural strength	30,000 psi
Flexural modulus	1.3 x 106 psi
Impact strength	20.0 ft-lbs/in
Water absorption	0.7% (in 24 hours)

2.2.2 Gates

Fiberglass Reinforced Polyester (FRP). Structural characteristics for an 1/8 inch glass mat laminate shall meet the following minimum physical properties.

Tensile strength	14,700 psi
Flexural modulus	800,000 psi
Flexural strength	23,300 psi
Impact strength	9.0 ft-lbs/in.
Water absorption	0.13% (in 24 hrs.)

2.2.3 Stems and Gate Hardware

T-316 Stainless Steel.

2.2.4 Closure Seals

2.2.4.1 Hollow Bulb J-seals

Molded of extruded virgin neoprene per ASTM D-2000. The following physical characteristics apply:

Specific gravity	1.25
Hardness	55 - 65 Shore A Durometer
Tensile strength	1,500 psi min.
Elongation	300 %
Low temperature brittleness	-40o F.

2.2.4.2 J-seal Clamping Bars and Fasteners

T-316 Stainless Steel.

2.2.5 Manual Operators

2.2.5.1 Lift Nuts and Thrust Nuts

Manganese bronze, ASTM B-584, Alloy 865.

2.2.5.2 Thrust Collar

Cast iron, ASTM A-126 Class B.

2.2.5.3 Handwheel

Cast iron, ASTM A-126 Class B.

2.2.5.4 Anchor Bolts

T-316 Stainless Steel.

2.3 CONSTRUCTION

2.3.1 Gates

Each gate shall be molded individually to the exact dimensions specified. Weir gates shall utilize sandwich core structural reinforcing to attain the necessary stiffness to meet deflection requirements, and shall be manufactured of reinforced thermoset plastic containing ultraviolet absorbers. The surface shall be resin rich to a depth of 0.010 inches to 0.020 inches and reinforced with C-glass or polymeric fiber surfacing material. The surface shall be free of exposed reinforcing fibers. The composition of these layers shall be approximately 95% (by weight) resin. The remaining laminate shall be made up of copolymer composite and reinforcing fibers in a form, orientation, and position to meet the mechanical requirements. Structural reinforcing shall be utilized to attain the necessary stiffness to meet deflection requirements, and shall be well encapsulated with a laminate not less than 1/8 inch thick on each side to insure against any permeation by water. T-316 Stainless Steel stem mounting bracket shall be provided on the gate for mating to the stem. Gates having reinforcing members bolted or bonded to flat sheet stock will not be acceptable. Size of gate to be as called out on drawings.

2.3.2 Seals

The gate shall be equipped with elastomeric top seals to reduce leakage. Resilient J-seals shall be made of molded or extruded virgin neoprene having a hardness of 55-65 Shore A Durometer, conforming to ASTM D-2000, with a maximum compression set of 25%, and a low temperature brittleness to meet suffix F-17 (-40oF). Seals shall be mounted on the guide with stainless steel or FRP clamping bars and stainless steel mounting hardware.

Down opening weir gates shall have a spigot back and side angles at the channel invert which form a straight and level mating surface for the gate to pass over. T-316 stainless steel flush head post nuts shall be used to anchor the channel invert. Neoprene J-seals shall be mounted to the side members and bottom invert of the guide.

2.3.3 Frames and Guides

Guides shall be styled for embedment, wall mounting or in-channel mounting

as needed to meet project requirements. The guides shall be fiberglass-reinforced polyester manufactured by the pultrusion process and shall incorporate a polymeric fiber surfacing material for high corrosion and weather resistance. The guide frame will have a 3/8 inch x 2 inch deep slot and shall have a minimum thickness of 1/4 inch. All guides shall be factory assembled with bonded corners using contoured butt straps. The corner shall be capable of withstanding a torque of 300 foot pounds pull applied parallel to the gate slot in either direction.

Where guides extend above the operating floor level to form a bench stand upon which the lift mechanism is fastened, they must be suitably strong and rigid without the use of additional stiffening members and shall have a maximum unsupported length of 3-feet-6-inches. The head rail shall have a maximum deflection of 1/4 inch when subjected to a horizontal force of four times the 40-pound maximum handwheel pull. Guides to extend below the invert of the wall opening as shown on the prints.

Where wall-mounted guides extend above a concrete wall, the top anchor bolt shall be not more than 6 inches below the top of the wall. Gate inverts shall be flush with the channel bottom.

Where guides are to be embedded in concrete, the back of the embedded portion of the guide shall have a continuous lip or flange extending not less than 3/8 inch on both sides, or may be drilled and fitted with 1-1/2 inch diameter pins, 6 inches on center, protruding 1-1 inch minimum on both sides to form a key into the concrete.

2.3.4 Lifts and Operators

Manual operators shall be cast iron with a bronze lift nut. Operators shall be sized to start the gate moving under maximum head pressure with a pull of not more than 40 pounds. A handwheel or crank shall be supplied that is compatible with the lift.

2.3.5 Operating Stems

Each slide gate shall be equipped with a rising operating stem. The stem shall be T-316 stainless steel with Acme threads and shall be provided with adjustable stop collars to limit upward and downward travel. Stems shall have a maximum L/r of 200. Stem guides with bronze bushings may be used so that the unsupported stem length does not exceed an L/r of 200.

2.3.6 Stem Covers

Transparent plastic stem cover shall be provided with vent holes to minimize condensation. The stem covers shall be attached by a threaded connection and shall be marked with "Open" and "closed" position indicators.

2.3.7 Travel

Weir Gate shall have a travel of 1.5'.

PART 3 EXECUTION

3.1 INSTALLATION

All slide gates shall be installed by skilled workers in accordance with the plans and specifications, and in full conformity with the instructions and recommendations of the equipment manufacturer.

-- End of Section --

SECTION 13110A

CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)

PART 1 GENERAL

1.1 REFERENCES

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

NACE INTERNATIONAL (NACE)

NACE RP0169	(1996) Control of External Corrosion on Underground or Submerged Metallic Piping Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Aluminum Anodes; G
Coal Tar Epoxy Coating; G
Sandblasting Test Procedures; G
Coating Application Procedures; G
Cathodic Protection Operations and Maintenance Manual; G

SD-06 Test Reports

Coating Holiday Test Report; G
Cathodic Protection Final Test Report System; G

SD-07 Certificates

Qualifications of Contractor's NACE Certified "Corrosion Specialist" ; G

Cathodic Protection Certification; G

1.3 GENERAL REQUIREMENTS

The Contractor shall furnish and install a complete, operating, sacrificial anode cathodic protection system in complete compliance with NFPA 70, with all applicable Federal, State, and local regulations and with minimum requirements of this contract. The services required include the application of coal tar epoxy coating to all of the exposed steel surfaces of Spillway No. 3 and the installation of galvanic (aluminum) anodes on the vertical columns of the spillway structure. The Contractor shall avoid damage to all existing structures and shall repair at no additional cost any and all damage that occurs to existing structures.

1.3.1 Services of "Corrosion Expert"

The Contractor shall obtain the services of a NACE Certified "Corrosion Specialist" to supervise, inspect, and test the installation and performance of the coating and the cathodic protection system.

PART 2 PRODUCTS

2.1 COATING

The coating for all steel spillway members, to be submerged or exposed to the atmosphere shall be a two component, high solids, chemically cured coal tar epoxy. The coating shall be formulated for maximum performance in severely corrosive environments, above ground, below ground and submerged in fresh or sea water. The coating shall be formulated to meet the United States Army Corps of Engineer Specification C-200 and the Steel Structures Painting Council Specification SSPC Paint 16. The coal tar epoxy coating shall be Royston Roskote 201 as manufactured by Royston Laboratories, Pittsburgh, Pennsylvania or approved equal.

2.2 ALUMINUM ANODES

2.2.1 Composition and Weight

The anodes shall be aluminum. Each anode shall have a nominal weight of 60 pounds. The composition of the high purity aluminum anode shall be as follows:

Indium	0.01% to 0.02%
Silicon	0.20% maximum
Zinc	2.8% to 3.5%
Copper	0.006% maximum
Iron	0.10 maximum
Mercury	none
Aluminum*	remainder

* Minimum 99.85% purity

2.2.2 Dimensions

Each anode shall have the following dimensions:

Length	24.0 inches
Width	5.0 inches
Height	5.0 inches

2.2.3 Fabrication

Each anode shall be cast on a bent steel mounting strap as shown on the design detail drawings. the steel mounting strap shall be 3/16 inch thick by 1 1/4 inches wide. The steel mounting strap shall extend 3 inches beyond each end of the aluminum anode and shall extend 8 inches below the anode.

2.2.4 Shipping

The anodes shall be shipped on wooden skids. The wooden skids and anodes shall be sealed within heat shrink plastic to prevent direct moisture contact to the anodes during shipment and storage prior to installation.

PART 3 EXECUTION

3.1 COAL TAR EPOXY COATING

3.1.1 Surface Preparation

Immediately before coating, abrasive-blast the steel to a near-white condition at least equal to the Society for Protecting Coatings Specification SSPC SP10. The average profile depth shall be 1.5 mils minimum. Re-blast structures not coated immediately following surface preparation to the original blast standards before coating application. Ensure that all surfaces to be coated are completely dry and free of any contamination at the time of coating.

3.1.2 Mixing

Mix the two component per the coating manufacturer's instructions utilizing mechanical mixing equipment. The useful pot life of the coating, as stated in the coating manufacturer's product data sheets, shall be strictly adhered to. Properly dispose of all coating that exceeds the useful pot life.

3.1.3 Application

Apply the coating in two coats. The coating may be applied by brush, roller or airless spray. The time interval between the first and second coat shall be in strict accordance with the coating manufacturer's published specifications. Apply the first coast to yield a dry film thickness of 10 to 12 mils. Apply the second coat so that the total dry film thickness of the two coats is between 20 and 24 mils. Ensure that no portion of the coating is less than the above specified minimum film thickness.

3.1.4 Testing

The Contractor's "Corrosion Specialist" shall thoroughly inspect the coated surfaces and perform coating thickness measurements at a minimum of 10 locations on each column. If area with deficient (less than 20 mils) thickness are found, they shall be repaired by the Contractor. The Contractor's "Corrosion Specialist" shall perform high voltage holiday testing of the entire coated surface in accordance with NACE RP0274. The Contractor shall repair any and all holidays in accordance with the coating manufacturer's recommendations.

3.2 ANODES

3.2.1 Installation

Aluminum anodes shall be welded to the spillway steel members at the locations shown on the Drawings. Remove the aluminum anodes from the shipping container and verify that all heat shrink plastics has been removed from the anode surface. clean the surface of the steel member at the points of attachment to bright metal to assure proper welding of the anode mounting straps to the steel columns. Weld the anode to steel member being certain to weld fully all three sides of both the top and bottom mounting straps. All welding must be performed by a certified welder and shall conform to all applicable welding standards.

3.2.2 Coating Repairs and Weld Coating

Repair all coating damage caused by welding and the installation of the anodes. The coating material and application for the repair shall be the same as the original specified coating. Coat all welds with the same coal tar epoxy coating.

3.2.3 Inspection

The Contractor's "Corrosion Specialist" shall thoroughly inspect the anode installations. Any and all installation defects shall be immediately repaired by the Contractor at no additional cost.

3.3 POST INSTALLATION TESTING

3.3.1 Qualifications

The Contractor shall provide a NACE International Certified "Corrosion Specialist" to perform post installation testing of the cathodic protection system. The testing, repair or replacement of any defective or improperly installed systems shall be the sole responsibility of the Contractor. All testing, and all repairs or replacement of defective or improperly installed cathodic protection components shall be performed by the Contractor at no additional cost. The results of all tests shall be submitted to the Engineer in a format acceptable to the Engineer.

3.3.2 Testing

The post installation testing shall consist of a structure-to-earth potential survey on the land side of the spillway structure and a structure-to-electrolyte potential survey on the water side of the spillway structure. The land side potential survey shall consist of obtaining structure-to-soil potentials on each vertical column that is accessible and is in contact with soil on the land side of spillway structure. The waterside potential survey shall consist of obtaining structure-to-electrolyte potentials at the surface of the water, mid depth and at the bottom of each vertical column that is accessible and is in contact with the water. All testing shall be performed with a calibrated silver/silver chloride reference electrodes in accordance with NACE RP0169.

The Contractor's "Corrosion Specialist" shall analyze test results in order that fully effective cathodic protection in accordance with NACE International RP0169 is achieved and certified. Should full protection in accordance with RP0169 not be achieved, then the Contractor shall install additional anodes in accordance with this specification at no additional cost, until full protection in accordance with NACE RP0169 is achieved.

3.3.3 Reports

3.3.3.1 Acceptance Testing

The Contractor's "Corrosion Specialist" shall provide assigned, final coating holiday and cathodic protection test report that includes a description fall test procedures; legible test data; legible sketches of test locations; and conclusions as to the condition of the coating and the operating status of the cathodic protection system. Certification that the cathodic protection system is functioning in accordance with NACE RP 0169 shall be included. The Contractor's "Corrosion Specialist" shall sign the test report and include their NACE certificate number with their signature.

3.3.3.2 Operations and Maintenance Manual

The Contractor's "Corrosion Specialist" shall provide a signed, detailed Operations and Maintenance Manual that includes all recommended test procedures, test frequency and instructions for analyses of test results.

-- End of Section --

SECTION 13217N

FIBERGLASS REINFORCED POLYESTER ENCLOSURE

PART 1 GENERAL

1.1 SUBMITTALS

Submit the following in accordance with Section 01330, "Submittal Procedures."

SD-02 Shop Drawings

Fiberglass reinforced polyester building; G

Template for anchor bolts

Submit as necessary to erect the building and install components.

SD-03 Product Data

Fiberglass reinforced polyester building materials

Submit sufficient data indicating conformance to specified requirements on materials provided under this section.

44SD-04 Samples

Factory color gelcoat finish

Submit one sample of each color indicated for verification that the color matches the colors indicated. Where colors are not indicated, submit not less than four different samples of manufacturer's standard colors for selection by the Contracting Officer.

SD-05 Design Data

Building; G

Foundation loads; G

Anchor bolts; G

SD-06 Test Reports

Factory color gelcoat finish

Insulation

SD-07 Certificates

Fiberglass reinforced polyester building materials

Submit certificates attesting that materials comply with this

specification.

SD-10 Operations and Maintenance Data

Fiberglass reinforced polyester building, data package; G

Submit operation and maintenance data in accordance with Section 01781, "Operation and Maintenance Data."

1.2 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle manufactured items so that materials remain dry and undamaged. Do not store in contact with materials that might cause staining.

1.3 WARRANTY

Provide warranty against water leaks arising out of or caused by ordinary wear and tear by the elements for a period of 20 years. Such warranty shall start upon final acceptance of the work or the date the Government takes possession, whichever is earlier.

PART 2 PRODUCTS

2.1 DIMENSIONS

The Contractor shall furnish and install at the location shown on the drawings, one completely insulated, corrosion resistant fiberglass reinforced polyester enclosure. The insulated fiberglass shelter shall be 6 feet wide by 6 feet long and have a wall height of 7 feet. The shelter wall shall be of ribbed construction for superior structural stability and each wall section shall be molded in one piece with a minimum thickness of 1 inch polyurethane foam encapsulated between 1/8 inch fiberglass reinforced skins. Minimum thickness at the rib sections shall be 2 inches. There shall be no embedded wood, treated or otherwise, and no embedded metal anywhere in the structure.

2.2 FRAMING

2.2.1 Roof

The shelter shall have a gabled roof with a minimum 2½ inch overhang all around. The roof shall be made of laminated fiberglass skins of not less than 1/8 inch thickness bonded on the inside and out to a core of polyurethane closed cell foam of 1 inch minimum thickness. Roof shall have a minimum of 1 to 24 slope.

2.2.2 Bolting Flange

Molded as an integral part of the walls along the bottom edge shall be a 4 inch fiberglass reinforced polyester bolting flange of minimum 3/16 inch thickness to allow permanent mounting on a pre-poured pad.

2.2.3 Door

An insulated fiberglass reinforced polyester door of similar construction to the shelter walls shall be mounted in a recess for increased tamper resistance. There shall be a clear opening of not less than 2 feet 7 inces wide by 6 feet 1 inch high with a raised all weather sill. The door opening shall be raised above the bottom of the wall to facilitate a

weathertight closure. The door shall have a resilient, closed cell foam neoprene seal per ASTM D 1056 to provide a tight closure on all four edges.

Door hardware shall include a 3 point door catch, T-304 stainless steel padlocking door handle, heavy duty stainless steel hinges, and a spring loaded door holder to help prevent door from closing during windy conditions.

a. Hinges shall be of the long strap design having ½ inch diameter stainless steel hinge pins with nylon liners. Hinges shall be bolted to the door and shelter. Rivets or other fasteners that do not permit door adjustment shall not be used.

b. The door handles shall be of the drop handle type having a large offset handle and escutcheon for a padlock. An inside door handle shall also be provided. There shall be a rain visor installed over the door. Mounting channel strut shall be laminated to the inside rear wall for supporting the electrical and control panels.

2.2.4 Finish

The exterior of the shelter shall be finished with a smooth (white) gelcoat surface of minimum 10 mil thickness.

2.3 STRUCTURAL

The shelter shall be capable of withstanding a 125 mph wind load and a 40 psf snow and ice load.

PART 3 EXECUTION

3.1 ERECTION

Erect in accordance with the manufacturer's approved erection instructions and diagrams. Correct defects and errors in the fabrication of building components in a manner approved by the Contracting Officer. If defects or errors in fabrication of components cannot be corrected, remove and provide nondefective components. When installing wall and roof systems, install closure strips, flashing, sealing material, and other accessories in accordance with building manufacturer's instructions to provide a weathertight system, free of abrasions, loose fasteners, and deformations.

-- End of Section --

SECTION 15050N

INTAKE SCREEN AND AIR BURST SYSTEM

PART 1 GENERAL

1.1 SUMMARY

Provide intake screen as specified herein and as shown on the drawings.

Provide a skid-mounted air burst backwas system consisting of compressor, receiver, valving, instrumentationa nd congtrols necessary to provide sufficient amount of air to backwash intake screen provided as specified herein ans as shown the drawings. The receiver may be separate depending upon size.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Intake Screen; G

Air Compressor; G

SD-03 Product Data

Intake screen materials

Air compressor materials

SD-05 Design Data

Air compressor sizing and motor

SD-07 Certificates

Intake screen materials

Air compressor storage vessel

Submit certificates attesting that materials comply with this specification.

SD-10 Operation and Maintenance Data

Intake screen, data package; G

Air compressor, data package; G

Submit operation and maintenance data in accordance with Section 01781, "Operation and Maintenance Data".

1.2 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle manufactured items sot that materials remain dry and undamaged.

1.3 WARRANTY

Provide warranty against defects arising out of or caused by ordinary wear and tear by the elements for a period of 10 years for the intake screen and 1 year for the air compressor.

1.4 QUALITY ASSURANCE

Screens and air burst system shall be manufactured by an ISO 9000 Certified company, fabricated by ASME Section IX Certified welders and the manufacture shall provide evidence of experience in having supplied at least ten assemblies of similar designs which have been in successful service for at least three years.

Screen and Airburst system shall be supplied by one manufacturer to ensure single source responsibility.

PART 2 PRODUCTS

2.1 INTAKE SCREENS

Intake Screen shall be cylindrical with circumferential slots that widen toward the inside of the cylinder. The screen surface wire shall be cross-wire welded to an appropriate support memeber so as to provide necessary strength with minial hydraulic resistance. Thescreeen shall include an itnernal flow collector poipe dcesigned to snsure a unofrm flow distribution throught eh screen slots during water intake. Screen shall be equipped with 2 inch pipe size internal air burst manifold assembly.

2.2 Wire and Slot

The surface wire shall be made of copper/nickel alloy to prevent build-up of zebra muscles. The screen slot opening shall be 0.1 inches. The open area for this slot opening shall be aminimum of 64%. Slot size shall be controlled and continuously monitored during manufacture.

2.3 Capacity

The intake screen capacity shall be 2700 GPM at a maximum slot velocity, due to water removal not to exceed 0.5 feet per second and the screen manufacturer must provide actual test data. At the design flow rate, the pressure drop through the surface of the clean screen shall not excee 0.1 psi. The toal pressure drop throught he Tee assembly shall not exceed 1.0 foot of water. Hydraulic calculation verifying compliance to these criteria shall be provided upon request.

2.4 Strength

Screen shall be capable of withstanding a differential hydrstatic pressure in excess of 4.3 pounds per square inch or a working depth of 10 feet of

water. The design stress when determining strength shall be two thirds of the yield stress. Strength calculation verifying compliance to these criteria shall be provided upon request.

2.5 Materials and Fittings

The wire and supports shall be copper/nickel alloy. The remainder of the assembly shall be manufactured of corrosion resistant metal, AISI type 316L stainless steel. The main outlet shall be an 18-inch plate flange with a bolt pattern equal to AWWA C207, Table 1, Class B. The air burst cleaning connection shall be through a 2 inch ANSI Class 150 raised face slip on flange.

2.6 AIR BURST SYSTEM

2.6.1 Compressor

An Ingersoll-Rand Type T-30 compressor equal with sufficient capacity to recharge receiver vessel to operating pressure of 150 psig within 30 minutes shall be provided. A two-year warranty shall be provided on compressor parts. Compressor shall be equipped with a low oil level switch. The compressor shall operate at 480 Volt, 3-Phase, 60 Hz. The compressor shall deliver a minimum of 14 CFM free air at 175 psig at ambient inlet conditions.

2.6.2 Receiver

An ASME Code 150 psi horizontal/vertical air receiver shall be provided. The receiver shall be provided with pressure gauge, safety valve, and automatic drain assembly. The receiver shall be sizaed to hold 2 to 3 screen volumes of air. The receiver capacity shall be 120 gallons. The receiver outlet shall be nominally 2 inches in diameter.

2.6.3 Controls

A NEMA 4 control panel shall be provided and pre-wired. Manual controls shall provide push button operation of backwash of each screen. A step down transformer shall be provided to furnish 110V control power. A quick safety disconnect shall be provided in a NEMA 12 enclosure to terminate power to the compressor and controls. For automatic operation, a timer and/or a PLC shall be provided to control the sequence of operation. A low oil annunciator on the control panel shall be provided. The control panel shall have an auto/off/manual selection switch. A 30-second delay is suggested between initiating backwash command and actually opening backwash valve. Provisions shall be provided for actuating alarms during this 30-second grace period. Alarms shall be provided by others. The system shall be designed to accept one electrical service hook-up. Motor starter(s) with overcurrent and overload protection shall be provided.

PART 3 EXECUTION

3.1 OPERATION

System shall operate in manual or automatic mode. In manual mode, the backwash will be initiated by pushing an activation button, which will open a control valve after a 30-second delay, provided the system is powered up and the receiver is fully pressurized. Once the receiver pressure drops below a preset value, a pressure switch initiates the starting of the compressor, which repressurize the receiver. When the receiver reaches the

preset pressure, the compressor shuts off automatically. In automatic mode, the backwash feature is initiated by a preset timer. During pump operation, the backwash should burst every hour. After a 30-second delay, the control valve is opened, and air is released to the screen for backwashing.

-- End of Section --

SECTION 15132A

SUBMERSIBLE PUMP, AXIAL-FLOW AND MIXED-FLOW TYPE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABEMA Std 9	(1990) Load Ratings and Fatigue Life for Ball Bearings
ABEMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S2.19	(1989; R 1992) Mechanical Vibration - Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Residual Unbalance

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 108	(1999) Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 176	(1997) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 276	(1998b) Stainless Steel Bars and Shapes
ASTM A 297/A 297M	(1997; R 1998) Steel Casting, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application
ASTM A 312/A 312M	(1999) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 576	(1990b; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A 668/A 668M	(1996) Steel Forgings, Carbon and Alloy, for General Industrial Use

ASTM B 584	(1998a) Copper Alloy Sand Castings for General Applications
ASTM D 2000	(1998a) Rubber Products in Automotive Applications

ASME INTERNATIONAL (ASME)

ASME B46.1	(1995) Surface Texture (Surface Roughness, Waviness, and Lay)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1998) Structural Welding Code - Steel

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(1997) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C203	(1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C207	(1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
AWWA C208	(1996) Dimensions for Fabricated Steel Water Pipe Fittings

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.5	(1994) Centrifugal Pumps
HI 2.1-2.5	(1994) Vertical Pumps
HI 2.6	(1994) Vertical Pump Test
HI 9.1-9.5	(1994) Pumps - General Guidelines

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA RP2.1	(1985) Manometer Tables

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1-1993; Rev 2-1995; Rev 3-1996; Rev 4-1997) Motors and Generators
NEMA WC 7	(1988; R 1991; Rev 1-1991; Rev 2-1992; Rev 3-1996) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

1.2 LUMP SUM PRICE

1.2.1 Submersible Non-clog Wastewater Pump

1.2.1.1 Payment

Payment will be made for costs associated with furnishing and installing the submersible pump as specified.

1.2.1.2 Unit of Measure

Unit of measure: lump sum.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submersible Pump; G, RE

Within 90 days of Notice of Award, submit drawings listed below. Submitted drawings shall be of sufficient size to be easily read. Submit information in the English language. Dimensions shall be in English units.

a. Outline drawings of the pump showing dimensions and weight of the pump/motor.

b. Drawings showing details and dimensions of pump mounting design and layout including any embedded items.

c. Cross-sectional drawings of the pump, showing each component, should show major or complicated sections of the pump in detail. On each drawing indicate an itemized list of components showing type, grade, class of material used, and make and model of the standard component used. Include detail and assembly drawings of entire pumping unit assembly.

d. Provide drawings covering the installation that the Contractor intends to furnish to the erecting engineer.

e. The capacity-head curve should indicate efficiency, bhp, and NPSHR.

f. Motor characteristic curves or tabulated data (test or calculated) should indicate the speed, power factor, efficiency, current, and kilowatt input, all plotted or tabulated against percent load as abscissas.

SD-03 Product Data

Materials;

Submit a list designating materials to be used for each pump part along with the submittal of the drawings.

If deviation from specified materials is desired, submit complete specifications for the proposed deviating materials after award of the contract.

Equipment Supplies and Performance; G, RE

Within 60 days of Notice of Award, submit the names of the manufacturers, performance capacities, and other relevant information for the machinery and other equipment contemplated to be incorporated into the work.

Spare Parts;

Submit 10 copies of manufacturers complete parts list showing all parts, spare parts, and bulletins for pump. Clearly show all details, parts, and adequately describe parts or have proper identification marks. The parts lists shall be printed on good quality 8 1/2 by 11 inch paper, bound separately of the Operation and Maintenance manual with a flexible, durable cover. Drawings incorporated in the parts lists may be reduced to page size provided they are clear and legible, or they may be folded into the bound lists to page size. Photographs or catalog cuts of components may be included for identification.

Computations; G, RE

Submit sufficient hydraulic computations to substantiate pump selection and demonstrate that the selected pump can meet the project design and operating requirements as specified.

Installation Instruction Manual; G, ED

No later than time of pump delivery, submit three copies of a typed and bound manual describing procedures to be followed by the installation engineer in assembling, installing, and dry- and/or wet-testing the pump. Coordinate and consolidate the description of the pump with similar descriptions for other specified pump parts. The description shall be of such a nature that it may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of this type. The description shall be a step-by-step explanation of operations required, and shall include, where applicable, such things as alignment procedures, bolt torque values, recommended instrument setups, recommended gauges and instruments, and similar details. The Contracting Officer may request changes or modifications to the manuals deemed necessary or desirable.

Factory Test;

Submit a description of the factory test setup and test procedure proposed. Submit data and drawings sufficient to demonstrate that testing is in compliance with HI 2.6.

Pump Field Tests; G, ED

Submit the field test plan prior to field testing.

SD-06 Test Reports

Factory Test Report; G, ED

Within 30 days of receipt of approval of the witnessed field test, submit nine bound copies of a report covering test setup and performance tests. The factory test report shall include the specified information.

Field Test Report; G, ED

Submit five (5) copies of the field test report.

Installation and Start-Up Engineer;

Submit the installation report.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instruction; G, ED

Submit 10 copies of the manual containing complete information on operation, lubrication, adjustment, routine and special maintenance disassembly, repair, reassembly, and trouble diagnostics of pump and auxiliary equipment. The operation and maintenance manual shall be printed on good quality 8 1/2 by 11 inch paper, bound separately from the parts list, and bound between a flexible, durable cover. Drawings incorporated in manual may be reduced to page size provided they are clear and legible, or they may be folded into the manual to page size. Photographs or catalog cuts of components may be included for identification.

1.4 SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS

1.4.1 General Project Requirements

Design, furnish, and install 2 submersible, non-clog wastewater pumping units for the Borrow Pit Pumping Station shown. Water pumped will not exceed 80 degrees F, will be relatively turbid, and may contain sand, silt, and trash capable of passing the intake screen, having 0.1 in. clear openings.

1.4.2 Pumping Unit Description

In general, each pumping unit includes a pump/motor, discharge tube, air vent, cable, and controls. The pump/motor shall be a submersible electric motor connected for operation on 460 volts, 3 phase, 60 hertz, with 25 feet of submersible cable (subcab) suitable for submersible pump applications. Except as otherwise stated or noted, the terms pump and pump/motor both refer to a pump/motor integral unit.

1.4.3 General Design Requirements

a. The pump shall meet head, capacity, speed, efficiency, pump sump design, range of operation, cavitation, and vibration requirements as specified.

b. The pump shall be designed for runaway speed as calculated by the Contractor for the system shown and specified. Waterhammer calculations shall be included when long discharge lines exist. The reverse speed shall be calculated assuming power failure and discharge

valves fail to close.

c. The pump shall, as a minimum, meet the applicable design, materials, and manufacture requirements of HI 1.1-1.5, HI 2.1-2.5, HI 9.1-9.5 and these specifications.

d. The pumping unit design and performance shall have been demonstrated by previous successful operation of pumps of the required type and of equal design complexity by the manufacturer.

e. The pump shall operate in a discharge tube. The discharge tube shall fit within the dimensions shown so that installation and maintenance can be carried out by a mobile crane. The weight of the pump/motor integral unit shall not exceed 1200 lb.

f. The pump shall be designed for the calculated hydraulic pressure including waterhammer to which the pump parts are exposed.

g. The pump losses, as calculated by the Contractor, are in addition to the specified head and shall be allowed for when computing the pump system output. The hydraulic quantities are as defined in HI 1.1-1.5.

h. The pump shall have a continuously rising head characteristic with decreasing capacity over the required range of operation specified. The pump shall not have an unstable operating characteristic over the required range of operation.

i. The pump shall meet all requirements for net positive suction head required (NPSHR) and operate without surging.

j. Associated pumping equipment including, but not limited to, electrical controls, instrumentation, and pump control center shall be suitable for outdoor operation.

k. The pumps shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There will be no need for personnel to enter the wet-well.

l. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to HDPE watertight contact. Sealing of the discharge interface with a diaphragm, O-ring, or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor.

1.4.4 Computations and Design of Discharge System

a. The pumping unit shall discharge into the discharge system shown. Losses within the pumping unit shall be determined by the Contractor.

b. Priming of the siphon will be accomplished without the assistance of vacuum equipment.

1.4.5 Operating Conditions

a. The pump shall be capable of operating in the dry (for the purpose of maintenance and operating checks) for short periods of time as stated in the manufacturer's operating instruction.

b. The pump manufacturer shall establish and state in the operating manual the procedures for starting and stopping the pumps, including setting of valves or any sequential operations.

1.4.6 Performance Requirements

a. When operated in the dry, the maximum level of vibration of the assembled pumping unit shall not be greater than the value of the lower limit of the good range of the "General Machinery Vibration Severity Chart". This chart can be obtained from Entek IRD, 1700 Edison Drive, Cincinnati, Ohio 45150. Measurements shall be taken at pump operating speed during the field start-up test.

b. The pump shall be capable of operating without instability over the required range of head.

1.4.7 Capacities

1.4.7.1 Lake Pump

a. Discharge shall not be less than 1,245 gpm against total design head 50 ft with water surface in the sump at elevation -1.3 ft.

b. The pump shall be supplied with a mating stainless steel 12 inch discharge connection. The pump shall be fitted with 20 feet of stainless steel lifting chain or cable.

1.4.7.2 MHS Pump

a. Discharge shall not be less than 736 gpm against total design head 176 ft with water surface in the sump at elevation -1.3 ft.

b. The pump shall be supplied with a mating stainless steel 14 inch discharge connection. The pump shall be fitted with 20 feet of stainless steel lifting chain or cable.

1.5 PUMP SUPPLIER EXPERIENCE AND RESPONSIBILITY

The pumps shall be designed and manufactured by a firm that is regularly engaged in the manufacture of the type of pump described in these specifications. The pump manufacturer shall have overall responsibility to supply the pumping unit (submersible pump/motor, discharge tube, cables) that meet the requirements of this specification. Thus, during start-up, installation, and performance evaluation, the pump manufacturer is the sole responsible party. The pump manufacturer shall supply a list of installations at which pumps of his manufacture, and ones similar to those specified, have been operating for at least 2 years. The components and materials of the pumping unit may occur at different facilities, and be the product of other manufacturers.

1.6 SHIPPING AND STORAGE

The pump will be inspected for damage or other distress when received at the project site. The pump and associated equipment shall be stored indoors as recommended by the pump manufacturer, protected from construction or weather hazards at the project site. The pump and equipment shall have adequate short-term storage in a covered, dry, and ventilated location prior to installation. The manufacturer's instructions shall be followed for extended storage. Proper equipment for handling the pump shall be supplied and shall be considered as special tools if not

completely standard.

1.7 SPECIAL TOOLS

Furnish one set of all special tools required to completely assemble, disassemble, or maintain the pumps. Special tools refers to oversized or specially dimensioned tools, special attachment or fixtures, or any similar items. Lifting devices required for use in conjunction with the crane shall be furnished.

1.8 INSTALLATION AND START-UP ENGINEER

The Contractor shall furnish a competent installation engineer fluent in the English language who is knowledgeable and experienced with the installation and start-up procedures for submersible pumps and the associated equipment specified. Installation/erecting engineers provided by this section shall include those from Contractor's suppliers. When so requested, the installation engineer shall be responsible for providing complete and correct direction during installation, initial starting, and subsequent operation of equipment until field tests are completed. The installation engineer shall initiate instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment. The installation engineer shall also keep a record of measurements taken during erection and shall furnish one copy to the Contracting Officer on request or on the completion of the installation of assembly or part. The erecting engineer shall instruct the Contracting Officer or others as designated in the operation and maintenance features of the pump units.

PART 2 PRODUCTS

2.1 MATERIALS AND METALWORK FABRICATION

Material selection shall be guided by HI 9.1-9.5 for corrosion, erosion, and abrasion resistance. Deviations from the specified materials shall be submitted in accordance with paragraph SUBMITTALS. The materials of construction shall comply with the following:

TABLE 1 - MATERIALS OF CONSTRUCTION

PART	MATERIAL
Discharge Bowl	Stainless steel
Suction Bell	Stainless steel
Pump bowl	Stainless steel
Impeller	Stainless steel
Shaft	Cold-rolled carbon steel
Wearing ring	Manufacturer's standard
Bolts, key, etc.	Stainless steel
O-rings	Nitrile rubber
Mechanical seals	Tungsten carbide
Discharge tube	Stainless steel

2.1.1 Designated Materials

Designated materials shall conform to the following specifications, grades, and classifications.

MATERIALS	SPECIFICATION, GRADE, CLASS
Coal Tar Protective Coatings	AWWA C203
Cold-Rolled Steel Bars	ASTM A 108, min, Wt. Strm 65,000 psi
Copper Alloy Castings	ASTM B 584, Alloy No. C93700
Corrosion-Resistant Alloy Castings	ASTM A 297/A 297M, Grade CA-15, CAGNN and CF-8M
Dimensions for Steel Water Pipe Fittings	AWWA C208
Hot-Rolled Stainless	ASTM A 576, Graded G10200, G10450, and G11410
Ring Flanges	AWWA C207, Class B
Rubber Products in Automotive Applications	ASTM D 2000
Seamless and Welded Austenitic Stainless Steel Pipe	ASTM A 312/A 312M
Stainless Bars and Shapes	ASTM A 276, Grades S30400 and S41000
Steel Forging	ASTM A 668/A 668M, Class F
Steel Pipe 6 in. and Larger	AWWA C200
Stainless Steel Plate	ASTM A 167, UNS S30400 or ASTM A 176, UNS S40500
Quality Steel	ASTM A 36/A 36M
Surface Texture	ASME B46.1

2.1.2 Bolted Connections

2.1.2.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers shall conform to requirements herein specified and the paragraphs SUBMERSIBLE PUMP and the subparagraph, NUTS AND BOLTS for types required. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

2.1.2.2 Materials Not Specifically Described

Materials not specifically described shall conform to the latest ASTM specification or to other listed commercial specifications covering class or kinds of materials to be used.

2.1.3 Flame Cutting of Material

Flame cutting of material other than steel shall be subject to the approval

of the Contracting Officer. Shearing shall be accurately done, and all portions of work neatly finished. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth surface free from cracks and notches is secured. Surfaces and edges to be welded shall be prepared in accordance with Section 3 of AWS D1.1. Chipping and/or grinding will not be required except where specified and as necessary to remove slag and sharp edges of technically guided or hand-guided cuts not exposed to view. Visible or exposed hand-guided cuts shall be chipped, ground, or machined to metal free of voids, discontinuities, and foreign materials.

2.1.4 Alignment of Wetted Surfaces

Exercise care to ensure that the correct alignment of wetted surfaces being joined by a flanged joint is being obtained. Where plates of the water passage change thickness, a transition shall occur on the outer surface, leaving the inner surface properly aligned. When welding has been completed and welds have been cleaned, but prior to stress relieving, joining of plates shall be carefully checked in the presence of a Government inspector for misalignment of adjoining parts.

2.2 SUBMERSIBLE PUMP

2.2.1 Design and Manufacture

At the Contractor's option, the submersible pump may be either of cast or fabricated construction. The level of manufacture skill shall be consistent with the standards referenced in the specifications. All work performed in the manufacture of the pumps shall be performed in a skillful and workmanlike manner in accordance with the best modern shop practice and manufacture of finished products similar in nature to those specified herein. The Government reserves the right to observe and witness the manufacture of the pumps and to inspect the pumps for compliance with standard good practice during factory assembly.

2.2.2 Speed

2.2.2.1 Runaway Speed

The pump shall be designed to sustain full runaway speed without damage at maximum head difference across the pump. Based on the system design as shown by the drawings the manufacturer shall compute the maximum reverse runaway speed, and the pump and motor shall be designed to sustain that reverse rotation without damage.

2.2.3 Pump Construction

2.2.3.1 General

The major pump components shall be of materials as described in Table 1. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. The fitting shall be such that the sealing is accomplished by metal-metal contact between machined surfaces which results in controlled compression of the O-rings. Sealing compounds, grease, or secondary devices are not acceptable.

Major pump components shall be of AISI type 329 stainless steel construction, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 316 stainless

steel construction.

2.2.3.2 Pump Lifting Handle And Lifting Lugs

The lifting handle shall be designed to bear the entire weight of the pumping unit at a conservative factor of safety (50% greater than the pump unit weight). Lifting lugs shall be provided where the weight of the separate part requires a lug. The contractor shall follow the manufacturers recommendations for handling of the pump.

2.2.3.3 Pump and Motor Bearing Arrangement

The pump and motor bearings shall be the standard design of the manufacturer for the pump supplied under this specification. The type and number shall be of proven design as used in previous operating units supplied by the manufacturer. The bearings shall be of the grease lubricated and sealed type. The bearings shall have a minimum B-10 bearing life of 50,000 hr. Each bearing shall be of the correct design to resist the radial and thrust loads applied. Enough bearings shall be provided to ensure the pump rotating elements are supported so that the possibility of excessive vibration is eliminated. Ball and roller bearings life and load ratings shall conform to ABEMA Std 9 and ABEMA Std 11.

2.2.3.4 Mechanical Seals

A mechanical rotating shaft seal system shall be provided between the impeller and motor to ensure the motor housing seal. The mechanical seals shall be in tandem, lapped and face type seals running in lubricant reservoirs for cooling and lubrication. The mechanical seals shall contain both stationary and rotating tungsten carbide face rings unless otherwise specified. In order to avoid seal failure from sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the lubricant housing. All seal faces must be solid material capable of being relapped. The seals shall require neither maintenance nor adjustment, but shall be easy to check and replace. Shaft seals without positively driven rotating members shall not be considered acceptable or equal.

2.2.3.5 Lubricant Housing

An oil housing shall be provided with oil, as recommended by the pump manufacturer, to lubricate the shaft sealing system and to dissipate the heat generated by the motor and bearings.

2.2.3.6 Impeller

The impeller design and manufacture shall be the manufacturer's standard. The impeller surface shall be smooth, without holes and fabrication offsets. The attachments to shaft shall be with keys or other fasteners which are to be made of stainless steel. The attachment should be of sturdy construction designed to not loosen, but be easily removed for maintenance. The impeller construction may be cast or fabricated. At the time of assembly the impeller clearances shall be those shown on assembly drawings and may be checked in the field or at the factory at the Contracting Officer's option.

The impeller shall be balanced at the design operating speed. The standard balance quality grade is G6.3 in accordance with ANSI S2.19. Balancing

procedure shall be in accordance with HI 2.1-2.5.

The impellers shall be of AISI type 329 stainless steel, dynamically balanced, double shrouded non-clogging design having a long throughlet without acute turns. The impellers shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Whenever possible, a full vaned, not vortex, impeller shall be used for maximum hydraulic efficiency; thus, reducing operating costs. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request. Impellers shall be capable of passing a minimum 0.2 inch diameter solid.

2.2.3.7 Shaft

The shaft shall be one piece integral with the motor of high-strength cold-rolled carbon steel with a factor of safety of five measured against the ultimate strength. The shaft shall be designed for all torque conditions during normal operation and for runaway speed during reverse flow.

2.2.3.8 Bowl Assembly

The bowl assembly may be of cast or fabricated manufacture. The hydraulic design shall be the manufacturer's standard design as used in previous operating installations. The general manufacture quality relating to flange design, drilling, bolts, alignments, etc., shall be in accordance with industry standard practice.

2.2.4 Motor

The motor shall be submersible and conform to the requirements of NEMA MG 1. The motor shall be sized to avoid overload when operating at any point along the characteristic curve of the pump. The motors shall be 3-phase, 60-Hz, 460 V, squirrel cage induction type, NEMA Design B Type. The stator windings and stator leads shall be insulated with a moisture-resistant Class F insulation with temperature resistance of 311 degrees F. The service factor shall be 1.0. The temperature rise above ambient for continuous full load rated conditions and for the class of insulation used shall not exceed the values in NEMA MG 1. The motor shall be rated for continuous duty when submerged and shall also be capable of operation in the dry for short periods of time for testing and maintenance purposes.

2.2.4.1 Torque

Starting torque shall be sufficient to start the pump, but in no case less than 60 percent of full-load torque. Break-down torque shall not be less than 200 percent of full-load torque.

2.2.4.2 Support

Thrust bearing support shall have sufficient strength and rigidity to support the weight of the entire rotating element of the motor, pump impeller and shaft, and the hydraulic thrust.

2.2.5 Cable

Power and instrumentation cable shall be specifically designed for use with a submersible pump application and shall conform to the requirements of NEMA WC 7. Submersible cable shall be suitable for continuous immersion in

water at the maximum depth encountered. Cable shall have an ampacity of not less than 125 percent of the motor full load current. The cable length shall be determined by the pump manufacturer for the installation shown.

2.2.5.1 Cable Entry

Power and instrumentation cables shall enter the motor through a sealing system that prevents water entry into the unit and provides strain relief. The cable entry may be comprised of rubber bushings, flanked by stainless steel washers, having a close tolerance fit against the cable outside diameter and the entry inside diameter for sealing by compression of the bushing, or the entry may be sealed by other gland compression methods.

2.2.6 Pump Control and Monitoring

A self-contained pump control and monitoring system shall be provided. Pump controls and control panels shall be provided in accordance with Section16492 16496. Independent local indication of the alarm and separate contacts for the remote indication of each alarm and local reset shall be provided. Sensors shall alarm and shut down the pump at an abnormal operating condition. Separate red alarm indicator lamps and green pump running lamps shall be provided and labeled in the ranger station. The following sensors shall be provided:

a. Temperature sensors in the stator windings to protect the motor against overheating.

b. Temperature sensors to monitor the main and support bearings.

c. Float-switch sensor positioned between the bearings and the stator-end coils to detect if liquid penetrates the stator housing.

d. A junction box leakage detector and a water-in-oil detector.

2.3 INTAKE DESIGN

2.3.1 General

The intake sump design is the Contracting Officer's responsibility. It is the responsibility of the contractor to supply a pump that will meet the performance requirements without undue modifications to the sump as shown on the drawings. Any such modifications shall be at no cost to the Government and must receive prior approval.2.4 PAINTING

The pump/motor shall be painted in accordance with the pump manufacturer's standard coating system.

2.5 SPARE PARTS

The Contractor shall furnish the following spare parts per pump:

a. One complete set of bearings and seals.

b. Replacement wearing rings and O-rings.

c. One impeller.

2.6 SHOP ASSEMBLY

The HDA discharge tube shall be assembled in the manufacturer's plant to ensure the proper fitting and alignment of all parts. Prior to disassembly, all parts shall be match-marked to facilitate the correct assembly in the field.

2.7 NAMEPLATE

The pumping unit shall be identified by means of a separate nameplate permanently affixed in a conspicuous location. The plate shall bear the manufacturer's name, model designation, serial number if applicable, and other pertinent information such as horsepower, speed, capacity, type, and direction of rotation. The plate shall be made of corrosion-resistant metal with raised or depressed lettering and a contrasting background.

2.8 INSTRUCTION PLATES

The pumping unit shall be equipped with suitably located instruction plates, including any warnings and cautions, describing any special and important procedures to be followed in starting, operating, and servicing the equipment. Plates shall be made of corrosion-resistant metal with raised or depressed lettering and a contrasting background.

2.9 FACTORY TEST

2.9.1 Performance Test

The pump shall be tested at the manufacturer's shop to demonstrate that the proposed pump operates without instability and complies with specified performance. Instability is defined when any point in usable range of the head-capacity curve cannot be repeated within 3 percent. When this occurs, the test shall be rerun. Compliance with specifications will be determined from curves required by the paragraph TEST RESULTS. Test procedures, except as herein specified, shall be in accordance with applicable provisions of HI 2.6. The temperature of the water used for testing shall be approximately the same for all tests run and shall be recorded during test runs.

2.9.1.1 Performance of the Pump

Performance of the pump shall be determined by a series of test points sufficient in number to develop a constant speed curve over the range of total heads corresponding to the requirements of the paragraph CAPACITIES. The test range shall include additional testing at total heads of 2 ft higher than that specified. The lowest total head for testing shall be, as a minimum, the total head determined from the referenced paragraph. If the test setup permits testing at lower total heads, the range of total heads shall be extended 2 ft lower. Testing shall be inclusive for the speed involved. Tests shall be made using heads and a suction water elevation specified in the paragraph CAPACITIES. Test results with this sump elevation shall meet all specified conditions of capacity, head, and bhp. Head differentials between adjacent test points shall not exceed 3 ft, but in no case shall less than 10 points be plotted in the pumping range. If the plot of data indicates a possibility of instability or a dip in the head-capacity curve, a sufficient number of additional points on each side of the instability shall be made to clearly define the head-capacity characteristics.

2.9.1.2 Test Results

Test results shall be plotted to show the total head, static heads, bhp, and efficiency as ordinates. The results should be plotted against pump discharge in gpm as the abscissa. Curves shall be plotted showing pump performance to a scale that will permit reading the head directly to 0.5 ft, capacity to 25 gpm, efficiency to 1 percent, and power input to 1 bhp. It shall be established that the performance requirements of these specifications and the warranties under this contract have been fulfilled. The performance test shall be made with the pump and motor assembled as an operating unit to simulate field installation unless otherwise approved in writing by the Contracting Officer. Readings shall include one point each within 2 percent of the rated total head, minimum expected head, and maximum expected head. The test shall be conducted in accordance with accepted practices at full speed; and, unless otherwise specified, the procedure and instruments used shall conform to HI 2.6.

2.9.2 Cavitation Test

The net positive suction head required (NPSHR) by the pump shall be determined by the testing procedures provided in HI 2.6. The Contractor shall select the test arrangement and procedure, from the choices provided in HI 2.6, that best suits the Contractor's test facility. NPSHR shall, as a minimum, be determined for five or more capacities over the total range of the specified operating conditions. The Contractor shall plot the test results and define NPSHR as the point where a 3% drop in performance occurs. The value of NPSHR shall be 2 ft less than the corresponding net positive suction head available (NPSHA). NPSHA shall be determined using the temperature of the water at the time the tests are run. The water elevations specified in paragraph CAPACITIES shall be used to determine the NPSHA for pumps.

2.9.3 Instrumentation and Procedures

Each instrument shall be described in detail, giving all data applicable, such as manufacturer's name, type, model number, certified accuracy, coefficient, ratios, specific gravity of manometer fluid to be used, and smallest scale division. When necessary for clarity, a sketch of the instrument or instrument arrangement shall be included. A fully detailed narrative description of each proposed method of instrumentation, procedures to be used, and a sample set of computation shall be included. The lowest equivalent static head that is obtainable with the testing when operating along the head-capacity curve of the proposed pump shall be stated.

2.9.3.1 Head Measurements

Head measurements shall be made using either a direct reading water column, mercury-air, mercury-water, a Meriam fluid manometer, or a pressure transducer. Vacuums shall be measured with either a mercury-air manometer, a mercury-water manometer, or a pressure transducer. Fluctuations shall be dampened sufficiently to permit column gauges or a differential pressure transducer to be read to either the closest one one-hundredth (0.01) of 1 ft of water or Meriam fluid or one-tenth (0.1) of 1 in. of mercury. Manometers shall be used as indicated by ISA RP2.1. When pressure transducers are used, their accuracy shall be checked with a manometer.

2.9.3.2 Pump Capacity

Capacity shall be determined by a calibrated venturi flowmeter or a long-radius ASME flow nozzle. Orifice plates should not be used. Venturi

or nozzle taps should be connected to column gauges equipped with dampening devices that will permit the differential head to be determined to either the closest one-hundredth (0.01) of 1 ft of water or one-tenth (0.1) of 1 in. of mercury. Magnetic flowmeters and flowmeters utilizing ultrasonic flow measurements will be acceptable if the calibration of the flowmeter has been completed within the last 6 months.

2.9.3.3 Rotational Speed of Pump

Rotational speed of the pump shall be measured in accordance with measurement of speed in HI 2.6, except that revolution counters shall not be used. The device used shall permit the speed to be determined to 10 rpms.

2.9.3.4 Power Input

Power input to the pump shall be measured in accordance with power measurements in HI 2.6. A method to permit bhp to be determined to the closest 0.5 bhp shall be used.

2.9.4 Witness Test

Factory test shall be performed in the presence of the Contracting Officer. When the Contractor is satisfied that the pump performs in accordance with the specified requirements, the Contracting Officer shall be notified, two weeks in advance, that the witness tests are ready to be run and furnish two copies of curves required in paragraph TEST RESULTS above. Should the test reveal that the pump does not perform in accordance with the specifications, the Contractor shall make necessary changes before again notifying the Contracting officer that witness tests are ready to be run. Copies of all data taken during the testing and plotted preliminary curves shall be given to the Contracting Officer at the conclusion of the test.

2.9.5 Factory Test Report

Each factory test report shall include, as a minimum, the following:

a. Statement of the purpose of test, name of project, contract number, and design conditions. Instances where guaranteed values differ from specified values should be given.

b. Resume of preliminary studies, if such studies were made.

c. Description of pump and motor, including serial numbers, if available.

d. Description of test procedure used, including dates, test personnel, any retest events, and witness test data.

e. List of all test instruments with model numbers and serial numbers.

f. Sample computations (complete).

g. A discussion of test results.

h. Conclusions.

i. Photographic evidence in the form of either 24 color photographs of test equipment, test setup and representative test segments, or a VHS

videotape, at least 30 minutes in length, covering the same information as photographs. All photographic evidence should be labeled with contract number, location, date/time, and test activity. Videotape shall be voice annotated with the same information.

j. Copies of instrument calibration.

k. Copies of all recorded test data.

l. Curves required by the paragraph TESTS RESULTS.

m. Curves showing the performance of the prototype pump.

n. Drawings of the test set-up showing all pertinent dimensions, elevations and cross section of the pump.

PART 3 EXECUTION

3.1 INSTALLATION

Correct installation and assembly of the pumping unit shall be the Contractor's responsibility and shall be in accordance with the drawings and with the manufacturer's installation instruction manual. The Contractor shall furnish all bolts, shims, tools, and other devices necessary for installing the pumping units. The manufacturer's representative(s) familiar with the equipment being installed shall supervise the handling, installation, start-up, and testing of the equipment as required in the paragraph INSTALLATION AND START-UP ENGINEER.

3.2 CLEANUP PRIOR TO START

After the pumping unit is installed and prior to start-up, complete clean up of the sump area of any accumulated construction debris shall be done. This final cleaning of the sump area will be witnessed by a representative of the Government. Any damage to the pumping units or related equipment during initial start-up due to foreign objects left in the sump areas shall be corrected at the Contractor's expense.

3.3 PUMP FIELD TESTS

Field testing shall be conducted by an experienced field test engineer and will be witnessed by the Contracting Officer. Before initially energizing the pump/motors, the Contractor shall have successfully tested all pumping plant control, monitoring, and protective circuits. This thorough electrical checkout procedure shall have followed a detailed step-by-step approved test plan. The motor and other pumping unit elements undergoing tests should also be checked at this time.

3.3.1 Dry Test

Each pumping unit shall be tested in the dry in accordance with the pump manufacturer's instructions to determine whether it has been properly installed. Such tests shall be made when, and as, directed by the Contracting Officer. The pump shall be operated at full rated speed. Should tests reveal a design or installation deficiency or a manufacturing error in pumping unit components, the problem shall be promptly corrected by and at the expense of the Contractor.

3.3.2 Wet Test

Each unit shall be given an operating test under load for a period of at least 8 hrs or as directed by the Contracting Officer. The tests shall be conducted by the Contractor and will be witnessed by the Government. During the tests, the operation of the pumping units shall be observed carefully and measurement of vibration and motor-bearing temperatures recorded. Vibration limits shall not exceed those recommended by HI 2.1-2.5. Without additional cost to the Government, the Contractor shall make all changes and correct any errors for which the Contractor is responsible.

3.3.3 Field Test Report

A test report of the field testing shall be prepared and submitted in accordance with paragraph SUBMITTALS.

-- End of Section --

SECTION 16375A

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C29.1	(1988; R 1996) Electrical Power Insulators - Test Methods
ANSI C37.46	(1981; R 1992) Power Fuses and Fuse Disconnecting Switches
ANSI C37.72	(1987) Manually-Operated Dead-Front, Padmounted Switchgear with Load-Interrupting Switches and Separable Connectors for Alternating-Current Systems
ANSI C57.12.21	(1995) Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings; (High-Voltage, 34 500 Grd Y/19 920 Volts and Below; Low-Voltage, 240/120; 167 kVA and Smaller)
ANSI C57.12.26	(1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVa and Smaller
ANSI C57.12.28	(1999) Switchgear and Transformers - Padmounted Equipment - Enclosure Integrity
ANSI C80.1	(1995) Rigid Steel Conduit - Zinc Coated
ANSI C119.1	(1986; R 1997) Sealed Insulated Underground Connector Systems Rated 600 Volts

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	(1994ael) Gray Iron Castings
ASTM A 123/A 123M	(2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M	(2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 3	(1995) Soft or Annealed Copper Wire
ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 496	(1999) Compact Round Concentric-Lay-Stranded Copper Conductors
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1997) Precast Reinforced Concrete Mahhole Sections (Metric)
ASTM D 923	(1997) Sampling Electrical Insulating Liquids
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 4059	(1996) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5	(1994; CS5a-1995) Cross-linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV
AEIC CS6	(1996) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a	(1998) Approval Guide Fire Protection

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C37.20.1	(1993) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C37.20.2	(1993; C37.20.2b) Metal-Clad and Station-Type Cubicle Switchgear
IEEE C37.20.3	(1997) Metal-Enclosed Interrupter Switchgear
IEEE C37.34	(1994) Test Code for High-Voltage Air Switches
IEEE C37.41	(1994; C37.41c) Design Tests for

	High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
IEEE C57.12.00	(1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.98	(1993) Guide for Transformer Impulse Tests
IEEE C62.1	(1989; R 1994) Surge Arresters for AC Power Circuits
IEEE C62.2	(1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
IEEE C62.11	(1999) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits
IEEE Std 48	(1998) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1997) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 386	(1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V
IEEE Std 404	(1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V
IEEE Std 592	(1990; R 1996) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA FB 1	(1993) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
NEMA LA 1	(1992) Surge Arresters
NEMA TC 6	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation

NEMA WC 7	(1988; Rev 3 1996) Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1988; Rev 3; 1996) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 467	(1993; Rev thru Apr 1999) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors
UL 489	(1996; Rev thru Dec 1998) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(1996; Rev Dec 1999) Metallic Outlet Boxes
UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit
UL 854	(1996; Rev Oct 1999) Service-Entrance Cables
UL 1242	(1996; Rev Mar 1998) Intermediate Metal Conduit

1.2 GENERAL REQUIREMENTS

1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office

that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Electrical Distribution System; G

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

a. Medium-voltage cables and accessories including cable installation plan.

b. Transformers.

e. Pad-mounted loadbreak switches.

g. Surge arresters.

As-Built Drawings; G

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings

shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

SD-03 Product Data

Nameplates; G

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment; G

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

General Installation Requirements; G

As a minimum, installation procedures for transformers, substations, switchgear, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-06 Test Reports

Factory Tests; G

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing; G

A proposed field test plan, 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field

test procedures including tests to be performed, test equipment required, and tolerance limits.

Operating Tests; G

Four (4) copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The condition specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

Cable Installation; G

Four (4) copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with cable pulls numerically identified.

b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.

c. The cable manufacturer and type of cable.

d. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pull and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.

SD-07 Certificates

Material and Equipment; G

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements.

The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

Cable Joints; G

A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

Cable Installer Qualifications; G

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

SD-10 Operation and Maintenance Data

Electrical Distribution System; G

Four (4) copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also

be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2 PRODUCTS

2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 NAMEPLATES

2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all switch positions shown and labeled. As a minimum, nameplates shall be provided for transformers, circuit breakers, meters, switches, and switchgear.

2.2.2 Liquid-Filled Transformer Nameplates

Power transformers shall be provided with nameplate information in accordance with IEEE C57.12.00. Nameplates shall indicate the number of gallons and composition of liquid-dielectric, and shall be permanently

marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 50 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 50 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

2.3 CORROSION PROTECTION

2.3.1 Ferrous Metal Materials

2.3.1.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

2.3.1.2 Equipment

Equipment and component items, including but not limited to transformer stations not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 2500 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

2.4.1 Medium-Voltage Cables

2.4.1.1 General

Cable construction shall be concentric neutral underground distribution cable conforming to AEIC CS5 and NEMA WC 7 . Cables shall be manufactured for use in duct applications as indicated.

2.4.1.2 Ratings

Cables shall be rated for a circuit voltage 15 kV .

2.4.1.3 Conductor Material

Underground cables shall be soft drawn copper complying with ASTM B 3 and ASTM B 8 for regular concentric and compressed stranding or ASTM B 496 for compact stranding .

2.4.1.4 Insulation

Cable insulation shall be ethylene-propylene-rubber (EPR) insulation conforming to the requirements of NEMA WC 8 and AEIC CS6 . A 133 percent

insulation level shall be used on 5 kV, 15 kV and 25 kV rated cables. Recyclable materials (insulation) shall conform to EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

2.4.1.5 Shielding

Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper [tape] [wire] shield for each phase. The shield [tape] [wire] shall be sized to meet IEEE C2 requirements for a ground fault availability of [_____] amperes.

2.4.1.6 Jackets

Cables shall be provided with a polyethylene jacket. Direct buried cables shall be rated for direct burial.

2.4.2 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

2.4.2.1 Conductor Material

Underground cables shall be annealed copper complying with ASTM B 3 and ASTM B 8 . Intermixing of copper and aluminum conductors is not permitted.

2.4.2.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

2.4.2.3 Jackets

Multiconductor cables shall have an overall polyethylene outer jacket.

2.4.2.4 Direct Buried

Single and multi-conductor cables shall of a type identified for direct burial. Service entrance cables shall conform to UL 854 for Type USE service entrance cable.

2.4.2.5 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70. .

2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

2.5.1 Medium-Voltage Cable Joints

Medium-voltage cable joints shall comply with IEEE Std 404 and IEEE Std 592. Medium-voltage cable terminations shall comply with IEEE Std 48. Joints shall be the standard products of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Joints shall have ratings not less than the ratings of the cables on which they are installed. Splice kits may be of the heat-shrinkable type for voltages up to 15 kV. Joints used in manholes

shall be certified by the manufacturer for waterproof, submersible applications.

2.5.2 Medium-Voltage Separable Insulated Connectors

Separable insulated connectors shall comply with IEEE Std 386 and IEEE Std 592 and shall be of suitable construction or standard splice kits shall be used. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the loadbreak type as indicated, of suitable construction for the application and the type of cable connected, and shall include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points and test points shall be provided.

2.5.3 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, conforming to the applicable requirements of UL 486A and UL 486B. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2.5.4 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 or Class 2; of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

2.5.4.1 Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level. Leakage distances shall comply with wet withstand voltage test requirements of IEEE Std 48 for the next higher Basic Insulation Level (BIL) level. .

2.6 CONDUIT AND DUCTS

Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application. Duct lines shall be concrete-encased, thin-wall type for duct lines between manholes and for other medium-voltage

lines.

2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

2.6.2 Nonmetallic Ducts

2.6.2.1 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 Type EB.

2.6.2.2 Direct Burial

UL 651 Schedule 40, or NEMA TC 6 Type DB.

2.6.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2.7 MANHOLES

Manholes shall be as indicated. Strength of manholes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48, Class 30B, minimum.

2.8 TRANSFORMERS

Transformers shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be 15 kV kV between phases for 133 percent insulation level.

2.8.1 [Enter Appropriate Subpart Title Here]2.8.2 Pad-Mounted Transformers

Pad-mounted transformers shall comply with ANSI C57.12.26 and shall be of the radial type. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of ANSI C57.12.26. Pentahead locking bolts shall be provided with

provisions for a padlock.

2.8.2.1 High-Voltage Compartments

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, drawout, dry-well-mounted, current-limiting fuses , medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. Fuses shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stencilled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on the same bushing as the primary cable by means of a loadbreak, feed-through bushing insert .

2.8.2.2 Load-Break Switch

Radial-feed oil-immersed type rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 10,000 ampere, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

2.8.2.3 Transformer Tank Sections

Transformers shall comply with IEEE C57.12.00, ANSI C57.12.21, and ANSI C57.12.26 and shall be of the mineral oil-insulated type less-flammable, liquid-insulated type with dimethyl silicone liquid. Transformers shall be suitable for outdoor use and shall have 2 separate windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided 2 above and 2 below rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as follows:

Three-phase capacity.....225 kVA.

Impedance.....6%.

Temperature Rise.....65 degrees C.

High-voltage winding.....13,200 volts.

High-voltage winding connections.....Delta.

Low-voltage winding.....480/227 volts.

Low-voltage winding connections..... ..... Wye

2.8.2.4 Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary.

2.8.2.5 Accessories

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. Dial-type thermometer, liquid-level gauge, and drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

2.8.3 Pad-Mounted, Metal-Enclosed, Switchgear

The switchgear shall be configured with 2 incoming compartments for loop-feed arrangement , equipped with air-insulated, load-interrupter switches oil-insulated, load-interrupter switches , as indicated. The outgoing compartments shall be provided with fused disconnects , as indicated.

2.8.3.1 Ratings at 60 Hz shall be:

Nominal voltage (kV).....14.4.

Rated maximum voltage (kV).....17.

Rated continuous current (A).....200.

Maximum symmetrical interrupting capacity (kA).....14.

Maximum asymmetrical interrupting capacity (kA).....22.4.

BIL (kV).....95.

2.8.3.2 Operators, Devices, and Controls

Operators and controls shall be provided for the switchgear as follows:

a. Switches shall be provided with a manual, handle-type operator or a push-button mechanical spring tripping mechanism, utilizing a stored-energy (spring-driven) mechanism to simultaneously open or close all phases. The switchgear shall be configured so that the switch actuator is padlockable, but may be accessed without opening the switch compartment doors.

b. Fused disconnects shall be hook-stick operated.

2.8.3.3 Enclosures

Switchgear enclosures shall be of freestanding, self-supporting construction provided with separate incoming and outgoing compartments configured for bottom cable entry. Enclosures shall be of deadfront construction, provided with a hinged door for access to each compartment,

and conform to the requirements of ANSI C57.12.28, ANSI C37.72, and IEEE C37.20.3, Category A.

2.9 PROTECTIVE DEVICES

2.9.1 Circuit Breakers, Low-Voltage

2.9.1.1 Molded-Case Circuit Breakers

NEMA AB 1 and UL 489.

2.9.2 Fuses, Medium-Voltage, Including Current-Limiting

2.9.2.1 Construction

Units shall be suitable for outdoor use. Fuses shall have integral blown-fuse indicators. All ratings shall be clearly visible.

2.9.2.2 Ratings

Current-limiting power fuses shall have ratings in accordance with ANSI C37.46 and as follows:

Nominal voltage.....14.4.

Rated maximum voltage.....17 kV.

Maximum symmetrical interrupting capacity.....22,400 amperes.

Rated continuous current.....30 amperes.

BIL.....95 kV.

2.9.2.3 E-Rated, Current-Limiting Power Fuses

E-rated, current-limiting, power fuses shall conform to ANSI C37.46.

2.10 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1, IEEE C62.1, IEEE C62.2, and IEEE C62.11 and shall be provided where indicated. Arresters shall be distribution class, rated as shown. Arresters for use at elevations in excess of 6000 feet above mean sea level shall be specifically rated for that purpose. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the metal-oxide varistor type.

2.11 GROUNDING AND BONDING

2.11.1 Driven Ground Rods

Ground rods shall be solid stainless steel not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used.

2.11.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same

material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2.12 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 03200 CONCRETE REINFORCEMENT.

2.13 PADLOCKS

Padlocks shall comply with Section 08710 DOOR HARDWARE.

2.14 CABLE FIREPROOFING SYSTEMS

Cable fireproofing systems shall be listed in FM P7825a as a fire-protective coating or tape approved for grouped electrical conductors and shall be suitable for application on the type of medium-voltage cables provided. After being fully cured, materials shall be suitable for use where exposed to oil, water, gases, salt water, sewage, and fungus and shall not damage cable jackets or insulation. Asbestos materials are not acceptable.

2.14.1 Fireproof Coating

Cable fireproofing coatings shall be compounded of water-based thermoplastic resins, flame-retardant chemicals, and inorganic noncombustible fibers and shall be suitable for the application methods used. Coatings applied on bundled cables shall have a derating factor of less than 5 percent, and a dielectric strength of 95 volts per mil minimum after curing.

2.14.2 Fireproofing Tape

Fireproofing tape shall be at least 2 inches wide and shall be a flexible, conformable, polymeric, elastomer tape designed specifically for fireproofing cables.

2.14.3 Plastic Tape

Preapplication plastic tape shall be pressure sensitive, 10 mil thick, conforming to UL 510.

2.15 LIQUID DIELECTRICS

Liquid dielectrics for transformers and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 trichlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than [50] [2] parts per million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding [50] [2] ppm shall be replaced.

2.16 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

a. Transformers: Manufacturer's standard routine design tests in accordance with IEEE C57.12.00.

b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line and neutral terminal, in accordance with IEEE C57.98.

c. High-Voltage Air Switches: Manufacturer's standard tests in accordance with IEEE C37.34 and IEEE C37.41.

g. Factory Preformed Terminations: Wet withstand voltage tests in accordance with IEEE Std 48 for the next higher BIL level.

h. Outdoor Switchgear: Manufacturer's standard tests in accordance with IEEE C37.20.1, IEEE C37.20.2, and IEEE C37.20.3.

i. Electrical Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.

2.17 [Enter Appropriate Subpart Title Here]PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3.2 CABLE INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature,

lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then prepare a checklist of significant requirements which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 1/4 inch less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 8 cubic inches of debris is expelled from the duct.

3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.

b. List of cable installation equipment.

c. Lubricant manufacturer's application instructions.

d. Procedure for resealing cable ends to prevent moisture from entering cable.

f. Cable percentage conduit fill.

g. Cable sidewall thrust pressure.

h. Cable minimum bend radius and minimum diameter of pulling wheels used.

i. Cable jam ratio.

j. Maximum allowable pulling tension on each different type and size of conductor.

k. Maximum allowable pulling tension on pulling device.

3.2.2 Duct Line

Low-voltage cables shall be installed in duct lines where indicated. Cable joints in medium-voltage cables shall be made in manholes or approved pullboxes only. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

3.3 CABLE JOINTS

Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable joints shall provide insulation and jacket equivalent to that of the associated cable. Armored cable joints shall be enclosed in compound-filled, cast-iron or alloy, splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

3.4 FIREPROOFING

Each medium-voltage cable and conductor in manholes shall be fire-proofed for their entire length within the manhole. Where cables and conductors have been lubricated to enhance pulling into ducts, the lubricant shall be removed from cables and conductors exposed before fireproofing.

3.4.1 Tape Method

Before application of fireproofing tape, plastic tape wrapping shall be applied over exposed metallic items such as the cable ground wire, metallic outer covering, or armor to minimize the possibility of corrosion from the fireproofing materials and moisture. Before applying fireproofing tape, irregularities of cables, such as at cable joints, shall be evened out with insulation putty. A flexible conformable polymeric elastomer fireproof tape shall be wrapped tightly around each cable spirally in 1/2 lapped wrapping or in 2 butt-jointed wrappings with the second wrapping covering

the joints of the first.

3.5 DUCT LINES

3.5.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. The high-point may be at a terminal. Short-radius manufactured 90-degree duct bends may be used only for equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

3.5.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.5.3 Concrete Encasement

Ducts requiring concrete encasements shall comply with NFPA 70. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, except railroad and airfield crossings, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.

3.5.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3.5.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

3.5.5 Duct Line Markers

Duct line markers shall be provided at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

3.6 MANHOLES

3.6.1 General

Manholes shall be constructed approximately where shown. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of each manhole shall be approved by the Contracting Officer before construction of the manhole is started. Manholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may at his option utilize monolithically constructed precast-concrete manholes having the required strength and inside dimensions as required by the drawings or specifications. In paved areas, frames and covers for manhole and handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 1/2 inch above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole. Duct lines entering cast-in-place concrete manholes shall be cast in-place with the manhole. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

3.6.2 Electric Manholes

Cables shall be securely supported from walls by glass reinforced nylon adjustable cable rack assemblies. Two cable racks indicated shall be installed oin each manhole wall and not less than 2 spare hooks shall be installed on each cable rack.

3.6.3 Ground Rods

A ground rod shall be installed at the manholes. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 4 inches of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

3.7 PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose.

3.7.1 Concrete Pads

3.7.1.1 Construction

Concrete pads for pad-mounted electrical equipment may be either pre-fabricated or poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 4 inches above finished paving or grade and sloped to drain. Edges of concrete pads shall have 3/4 inch chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

3.7.1.2 Concrete and Reinforcement

Concrete work shall have minimum 3000 psi compressive strength and comform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 03200 CONCRETE REINFORCEMENT.

3.7.1.3 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.7.2 Padlocks

Padlocks shall be provided for pad-mounted equipment and for each fence gate. Padlocks shall be keyed alike as directed by the Contracting Officer.

3.8 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 5 feet outside of a building and [2] [_____] feet below finished grade as specified and provided under Section 16415 ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed [with caulking compound] [_____] to prevent entrance of moisture or

gases into buildings.

3.9 GROUNDING

A ground ring consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed around pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from a transformer, a switchgear ground bus, a unit substation to the ground mat. Metallic frames and covers of handholes and pull boxes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

3.9.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade.

b. Ground mat - A ground mat shall be installed as shown consisting of bare copper conductors installed 12 inches, plus or minus 3 inches, below the finished top of soil grade. Mat conductors shall be bonded to all rod electrodes, electrolytic electrodes, and to all other intersecting mat conductors. Mat conductors shall be sized as shown on the drawings.

d. Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors to achieve the specified ground resistance. The additional electrodes will be up to three, 10 feet rods spaced a minimum of [10] [12] feet apart . In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

3.9.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

3.9.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground

conductor, and the opening shall be sealed with a suitable compound after installation.

3.9.4 Surge Arrester Grounding

Surge arresters and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with a bare copper conductor, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends.

3.9.5 Manhole

Ground rods installed in manholes shall be connected to cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

3.10 FIELD TESTING

3.10.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

3.10.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.10.3 Ground-Resistance Tests

The resistance of each grounding electrode the ground ring shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - 25 ohms.

b. Multiple rod electrodes - 25 ohms.

d. Ground ring - 25 ohms.

3.10.4 Medium-Voltage Cable Test

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed, except that 28 kV and 35 kV insulation test voltages shall be in accordance with either AEIC CS5 or AEIC CS6 as applicable, and shall not exceed the recommendations of IEEE Std 404 for cable joints and IEEE Std 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.10.5 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

3.10.6 Liquid-Filled Transformer Tests

The following field tests shall be performed on all liquid-filled transformers . Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

a. Insulation resistance test phase-to-ground.

b. Turns ratio test.

c. Correct phase sequence.

d. Correct operation of tap changer.

3.10.7 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers. Pass-fail criteria shall be in accordance with the circuit breaker manufacturer's specifications.

a. Insulation resistance test phase-to-phase.

b. Insulation resistance test phase-to-ground.

c. Closed breaker contact resistance test.

d. Power factor test.

e. High-potential test.

f. Manual and electrical operation of the breaker.

3.10.8 Pre-Energization Services

Calibration, testing, adjustment, and placing into service of the installation shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of 2 years of current product experience. The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to ensure that installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment to ensure packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

a. Secondary unit substation

b. Pad-mounted transformers

c. Panelboards

e. Metal-enclosed switchgear

g. Switches

3.10.9 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted

in accordance with paragraph SUBMITTALS.

3.11 MANUFACTURER'S FIELD SERVICE

3.11.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations.

3.11.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3.12 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

SECTION 16415A

ELECTRICAL WORK, INTERIOR

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
ANSI C78.1	(1991; C78.1a; R 1996) Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics
ANSI C78.1350	(1990) 400-Watt, 100-Volt, S51 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1351	(1989) 250-Watt, 100-Volt S50 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1352	(1990) 1000-Watt, 250-Volt, S52 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1355	(1989) 150-Watt, 55-Volt S55 High-Pressure Sodium Lamps
ANSI C78.1375	(1996) 400-Watt, M59 Single-Ended Metal-Halide lamps
ANSI C78.1376	(1996) 1000-Watt, M47 Single-Ended Metal-Halide Lamps
ANSI C82.1	(1997) Specifications for Fluorescent Lamp Ballasts
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1	(1995) Hard-Drawn Copper Wire
ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(1992; R 1997) Laminated Thermosetting Materials

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 18	Industrial, Scientific, and Medical Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures
NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	(1995) Panelboards
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 101	(1997; Errata 97-1; TIA 97-1) Life Safety Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 20	(1995; Rev thru Oct 1998) General-Use Snap Switches
UL 50	(1995; Rev thru Oct 1997) Enclosures for Electrical Equipment
UL 67	(1993; Rev thru Nov 1995) Panelboards
UL 83	(1998) Thermoplastic-Insulated Wires and Cables
UL 98	(1994; R thru Jun 1998) Enclosed and Dead-Front Switches
UL 360	(1996; Rev thru Oct 1997) Liquid-Tight Flexible Steel Conduit
UL 467	(1993; Rev thru Aug 1996) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(1997; Rev thru Aug 1998) Splicing Wire Connectors
UL 486E	(1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(1996; Rev thru Dec 1998) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 506	(1994; Rev Oct 1997) Specialty Transformers
UL 508	(1999) Industrial Control Equipment
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 514A	(1996; Rev Jul 1998) Metallic Outlet Boxes
UL 514B	(1997; Rev Oct 1998) Fittings for Cable and Conduit

UL 542	(1994; Rev thru Jul 1998) Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 674	(1994; Rev thru Oct 1998) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations
UL 845	(1995; Rev Feb 1996) Motor Control Centers
UL 854	(1996; Rev Apr 1998) Service-Entrance Cables
UL 869A	(1998) Reference Standard for Service Equipment
UL 943	(1993; Rev thru May 1998)Ground-Fault Circuit-Interrupters
UL 1004	(1994; Rev thru Dec 1997) Electric Motors
UL 1029	(1994; Rev thru Dec 1997) High-Intensity-Discharge Lamp Ballasts
UL 1242	(1996; Rev Mar 1998) Intermediate Metal Conduit
UL 1570	(1995; Rev thru Jun 1997) Fluorescent Lighting Fixtures
UL 1572	(1995; Rev thru Jun 1997) High Intensity Discharge Lighting Fixtures
UL 1660	(1994; Rev Apr 1998) Liquid-Tight Flexible Nonmetallic Conduit

1.2 GENERAL

1.2.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated or shown.

1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be carefully coordinated with mechanical or structural features prior to installation and positioned according to architectural reflected ceiling plans; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any

change. The Contractor shall coordinate the electrical requirements of the mechanical work and provide all power related circuits, wiring, hardware and structural support, even if not shown on the drawings.

1.2.3 Special Environments

1.2.3.1 Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

1.2.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.2.5 Nameplates

1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch High Letters	Minimum 1/8 inch High Letters
Panelboards	Control Power Transformers
Starters	Control Devices
Safety Switches	
Transformers	
Equipment Enclosures	
Motors	

1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish 2 sets of as-built drawings to the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Interior Electrical Equipment; G.

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

a. Transformers.

b. Panelboards.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment;

internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

SD-03 Product Data

Manufacturer's Catalog; G.

Data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material, Equipment, and Fixture Lists; G.

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

As-Built Drawings; G.

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

Onsite Tests; G.

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-06 Test Reports

Factory Test Reports; G.

Four (4) copies of the information described below in 8 1/2 x 11

inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

Field Test Plan; G.

A detailed description of the Contractor's proposed procedures for onsite test submitted 20 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; G.

Four (4) copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

a. A list of equipment used, with calibration certifications.

b. A copy of measurements taken.

c. The dates of testing.

d. The equipment and values to be verified.

e. The conditions specified for the test.

f. The test results, signed and dated.

g. A description of adjustments made.

h. Final position of controls and device settings.

SD-07 Certificates

Materials and Equipment; G.

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or

listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

2.1.2 Aluminum Conductors

Aluminum conductors shall not be used.

2.1.3 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN, THHN, or THW conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW, THW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C)

conductors, provide only conductors with 90-degree C insulation or better.

2.1.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.1.5 Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, UL 854.

2.2 CIRCUIT BREAKERS

2.2.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489.

2.2.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper conductors only in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.2.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1.

2.2.1.3 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

2.2.2 SWD Circuit Breakers

Circuit breakers rated 15 amperes and intended to switch 277 volts or less

fluorescent lighting loads shall be marked "SWD."

2.2.3 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

2.2.4 Ground Fault Circuit Interrupters

UL 943. Breakers equipped with ground fault circuit interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.

2.3 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors shall conform to UL 508 and shall be provided as shown. Protectors shall be used only as part of a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of NFPA 70.

2.3.1 Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

2.3.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

CONTROLLER SIZE	MSCP DESIGNATION
NEMA 0	A-N
NEMA 1	A-P
NEMA 2	A-S
NEMA 3	A-U
NEMA 4	A-W
NEMA 5	A-Y

2.4 CONDUIT AND TUBING

2.4.1 Flexible Conduit, Steel

Liquid tight, UL 360, and UL 1660.

2.4.2 Intermediate Metal Conduit

UL 1242.

2.4.3 PVC Coated Rigid Steel Conduit

NEMA RN 1.

2.4.4 Rigid Metal Conduit

UL 6.

2.5 CONDUIT AND DEVICE BOXES AND FITTINGS

2.5.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A.

2.5.2 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

2.5.3 Fittings for Conduit and Outlet Boxes

UL 514B.

2.6 CONDUIT COATINGS PLASTIC RESIN SYSTEM

NEMA RN 1, Type A-40.

2.7 CONNECTORS, WIRE PRESSURE

2.7.1 For Use With Copper Conductors

UL 486A.

2.8 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

2.8.1 Ground Rods

Ground rods shall be of solid stainless steel not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

2.9 ENCLOSURES

NEMA ICS 6 or NEMA 250 unless otherwise specified.

2.9.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

2.9.2 Circuit Breaker Enclosures

UL 489.

2.10 LIGHTING FIXTURES, LAMPS, BALLASTS, EMERGENCY EQUIPMENT, CONTROLS AND ACCESSORIES

The following specifications are supported and supplemented by information and details on the drawings. Additional fixtures, if shown, shall conform to this specification. Lamps, lampholders, ballasts, transformers, electronic circuitry and other lighting system components shall be constructed according to industry standards. Equipment shall be tested and listed by a recognized independent testing laboratory for the expected installation conditions. Equipment shall conform to the standards listed below.

2.10.1 Lamps

Lamps shall be constructed to operate in the specified fixture, and shall function without derating life or output as listed in published data. Lamps shall meet the requirements of the Energy Policy Act of 1992.

b. Fluorescent lamps shall have color temperature 3,500 . They shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used. Fluorescent lamps, including spares, shall be manufactured by one manufacturer to provide for color and performance consistency. Fluorescent lamps shall comply with ANSI C78.1. Fluorescent tube lamp efficiencies shall meet or exceed the following requirements.

T8, 32 watts	(4' lamp)	2800 lumens

(1) Linear fluorescent lamps, unless otherwise indicated, shall be 4 feet long 32 watt T8, 265 mA, with minimum CRI of 75. Lamps shall deliver rated life when operated on rapid start ballasts as shown.

c. High intensity discharge lamps, including spares, shall be manufactured by one manufacturer in order to provide color and performance consistency. High intensity discharge lamps shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used and shall have wattage, shape and base as shown. High intensity discharge lamps, unless otherwise shown, shall have medium or mogul screw base and minimum starting temperature of -20 degrees F. Metal halide lamps, unless otherwise shown, shall have minimum CRI of 65; color temperature of 4,300 degrees Kelvin; shall be -BU configuration if used in base-up position; and shall be -H or high output configuration if used in horizontal position. Lamps shall comply with all applicable ANSI C78.1350, ANSI C78.1351, ANSI C78.1352, ANSI C78.1355,ANSI C78.1375, and ANSI C78.1376.

2.10.2 Ballasts and Transformers

Ballasts or transformers shall be designed to operate the designated lamps within their optimum specifications, without derating the lamps. Lamp and ballast combinations shall be certified as acceptable by the lamp manufacturer.

b. Fluorescent ballasts shall comply with ANSI C82.1 and shall be mounted integrally within fluorescent fixture housing unless

otherwise shown. Ballasts shall have maximum current crest factor of 1.7; high power factor; Class A sound rating; maximum operating case temperature of 77 degrees F above ambient; and shall be rated Class P. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture. A single ballast may be used to serve multiple fixtures if they are continuously mounted, identically controlled and factory manufactured for that installation with an integral wireway.

(2) Electronic fluorescent ballasts shall comply with 47 CFR 18 for electromagnetic interference. Ballasts shall withstand line transients per IEEE C62.41, Category A. Ballasts shall have total harmonic distortion between 10 and 20%; minimum frequency of 20,000Hz; filament voltage between 2.5 and 4.5 volts; maximum starting inrush current of 20 amperes; and shall comply with the minimum Ballast Efficacy Factors shown in the table below. Minimum starting temperature shall be 0 degrees Fas shown. Ballasts shall carry a manufacturer's full warranty of three years, including a minimum $10 labor allowance per ballast.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL VOLTAGE	NUMBER OF LAMPS	MINIMUM BALLAST EFFICACY FACTOR
32W T8	rapid	120 or 277 V	1	2.54
	start		2	1.44
	linear &		3	0.93
	U-tubes		4	0.73

c. High intensity discharge ballasts shall comply with UL 1029 and, if multiple supply types, with ANSI C82.4. Ballasts shall have minimum ballast factor of 0.9; high power factor; Class A sound rating; and maximum operating case temperature of 77 degrees F above ambient.

(2) Magnetic high intensity discharge ballasts shall have a minimum starting temperature of -20 degrees F.

2.10.3 Fixtures

Fixtures shall be in accordance with the size, shape, appearance, finish, and performance shown. Unless otherwise indicated, lighting fixtures shall be provided with housings, junction boxes, wiring, lampholders, mounting supports, trim, hardware and accessories for a complete and operable installation. Plastic lenses shall be 100% virgin acrylic or as shown. Glass lenses shall be tempered. Heat resistant glass shall be borosilicate type.

b. Fluorescent fixtures shall comply with UL 1570. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles. Integral ballast and wireway compartments shall be easily accessible without the use of special tools. Housings shall be

constructed to include grounding necessary to start the lamps. Medium bi-pin lampholders shall be twist-in type with positive locking position.

c. High intensity discharge fixture shall comply with UL 1572. Lampholders shall be pulse-rated to 5,000 volts. Fixtures indicated for special service shall be designed and independently tested for the environment in which they are installed. Ballasts shall be integral to fixtures and shall be accessible without the use of special tools. Lamps shall be shielded from direct view with a UV absorbing material such as tempered glass, and shall be circuited through a cut-off switch which will shut off the lamp circuit if the lens is not in place.

2.10.4 Lampholders, Starters, and Starter Holders

UL 542

2.11 [Enter Appropriate Subpart Title Here]2.12 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.13 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004for motors; NEMA MG 10 for energy management selection of polyphase motors; and UL 674 for use of motors in hazardous (classified) locations. In addition to the standards listed above, motors shall be provided with efficiencies as specified in the table "MINIMUM NOMINAL EFFICIENCIES" below.

2.13.1 Rating

The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2.13.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motor efficiencies indicated in the tables apply to general-purpose, single-speed, polyphase induction motors. Applications which require definite purpose, special purpose, special frame, or special mounted polyphase induction motors are excluded from these efficiency requirements. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

MINIMUM NOMINAL MOTOR EFFICIENCIES
OPEN DRIP PROOF MOTORS

kW	1200 RPM	1800 RPM	3600 RPM

MINIMUM NOMINAL MOTOR EFFICIENCIES

0.746	82.5	85.5	80.0
1.12	86.5	86.5	85.5
1.49	87.5	86.5	86.5
2.24	89.5	89.5	86.5
3.73	89.5	89.5	89.5
5.60	91.7	91.0	89.5
7.46	91.7	91.7	90.2
11.2	92.4	93.0	91.0
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	93.6
44.8	95.0	95.0	94.1
56.9	95.0	95.0	94.5
74.6	95.0	95.4	94.5
93.3	95.4	95.4	95.0
112.0	95.8	95.8	95.4
149.0	95.4	95.8	95.4
187.0	95.4	96.2	95.8
224.0	95.4	95.0	95.4
261.0	94.5	95.4	95.0
298.0	94.1	95.8	95.0
336.0	94.5	95.4	95.4
373.0	94.5	94.5	94.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

kW	1200 RPM	1800 RPM	3600 RPM
0.746	82.5	85.5	78.5
1.12	87.5	86.5	85.5
1.49	88.5	86.5	86.5
2.24	89.5	89.5	88.5
3.73	89.5	89.5	89.5
5.60	91.7	91.7	91.0
7.46	91.7	91.7	91.7
11.2	92.4	92.4	91.7
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	94.1
44.8	94.5	95.0	94.1
56.9	95.0	95.4	94.5
74.6	95.4	95.4	95.0
93.3	95.4	95.4	95.4
112.0	95.8	95.8	95.4
149.0	95.8	96.2	95.8
187.0	95.6	96.2	95.9
224.0	95.4	96.1	95.8
261.0	94.5	96.2	94.8
298.0	94.5	95.8	94.5
336.0	94.5	94.5	94.5
373.0	94.5	94.5	94.5

MINIMUM NOMINAL MOTOR EFFICIENCIES
OPEN DRIP PROOF MOTORS

TOTALLY ENCLOSED FAN-COOLED MOTORS

HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	80.0
1.5	86.5	86.5	85.5
2	87.5	86.5	86.5
3	89.5	89.5	86.5
5	89.5	89.5	89.5
7.5	91.7	91.0	89.5
10	91.7	91.7	90.2
15	92.4	93.0	91.0
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	93.6
60	95.0	95.0	94.1
75	95.0	95.0	94.5
100	95.0	95.4	94.5
125	95.4	95.4	95.0
150	95.8	95.8	95.4
200	95.4	95.8	95.4
250	95.4	96.2	95.8
300	95.4	95.0	95.4
350	94.5	95.4	95.0
400	94.1	95.8	95.0
450	94.5	95.4	95.4
500	94.5	94.5	94.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

HP	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	78.5
1.5	87.5	86.5	85.5
2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7.5	91.7	91.7	91.0
10	91.7	91.7	91.7
15	92.4	92.4	91.7
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	94.1
60	94.5	95.0	94.1
75	95.0	95.4	94.5
100	95.4	95.4	95.0
125	95.4	95.4	95.4
150	95.8	95.8	95.4
200	95.8	96.2	95.8
250	95.6	96.2	95.9
300	95.4	96.1	95.8
350	94.5	96.2	94.8
400	94.5	95.8	94.5
450	94.5	94.5	94.5
500	94.5	94.5	94.5

2.14 MOTOR CONTROLS

2.14.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845.

2.14.2 Motor Starters

Combination starters shall be provided with circuit breakers as indicated.

2.14.2.1 Reduced-Voltage Starters

Reduced-voltage starters shall be provided for polyphase motors [_____] hp or larger. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starter or part winding increment starter having an adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced voltage starters specified above for starting of motor-generator sets, centrifugally operated equipment or reciprocating compressors provided with automatic unloaders.

2.14.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2.14.4 Low-Voltage Motor Overload Relays

2.14.4.1 General

Thermal and magnetic current overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds. Slow units shall be used for motor starting times from 8 to 12 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps, and similar motors.

2.14.4.2 Construction

Manual reset type thermal relay shall be melting alloy or bimetallic construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

2.14.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable

overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2.14.5 Automatic Control Devices

2.14.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

2.14.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.14.5.3 Manual/Automatic Selection

a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.

b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.

c. Connections to the selector switch shall be such that; only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low-or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

2.15 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67.

2.16 RECEPTACLES

2.16.1 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles.

2.16.2 Ground Fault Interrupters

UL 943, Class A or B.

2.16.3 NEMA Standard Receptacle Configurations

NEMA WD 6.

a. Single and Duplex, 15-Ampere and 20-Ampere, 125 Volt

20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

2.17 Service Entrance Equipment

UL 869A.

2.18 SPLICE, CONDUCTOR

UL 486C.

2.19 [Enter Appropriate Subpart Title Here]2.20 SNAP SWITCHES

UL 20.

2.21 TAPES

2.21.1 Plastic Tape

UL 510.

2.22 TRANSFORMERS

Three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with delta-wye windings, except as indicated. "T" connections may be used for transformers rated 15 kVA or below.

2.22.1 Transformers, Dry-Type

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation system for transformers rated 10 kVA and less, with temperature rise not exceeding 80 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 80 degrees C temperature rise shall be capable of carrying continuously 130 percent of nameplate kVA without exceeding insulation rating.

a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, unventilated epoxy-resin cast coil,. Transformers shall be provided in NEMA 3R enclosure.

2.22.2 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 12 inches for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50

2.23 WIRING DEVICES

NEMA WD 1 for wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

PART 3 EXECUTION

3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, 2 additional rods not less than 6 feet on centers. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.1.2 Grounding Conductors

[A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance grounding connection or separately derived grounding connection.] All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70. When switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid galvanized steel conduit, intermediate metal conduit, and PVC coated rigid conduit. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified.

3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes

shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70.

3.2.1.1 Pull Wires

A pull wire shall be inserted in each empty raceway in which wiring is to be installed if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200 pounds per square inch tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3.2.1.3 Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

3.2.1.4 Installing in Slabs Including Slabs on Grade

Conduit installed in slabs-on-grade shall be rigid steel or IMC. Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer. Where conduit is run parallel to reinforcing steel, the conduit shall be spaced a minimum of one conduit diameter away but not less than one inch from the reinforcing steel.

3.2.1.5 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Lodgment of plaster, dirt, or trash in raceways,

boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3.2.1.6 Supports

Metallic conduits and tubing,and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.

3.2.1.7 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings.

3.2.1.8 Communications Raceways

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirement that no length of run shall exceed 50 feet for 1/2 inch and 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall not be less than ten times the nominal diameter.

3.2.2 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of

circuits rated 600 volts or less.

3.2.2.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

3.2.2.2 Use of Aluminum Conductors in Lieu of Copper

Aluminum conductors shall not be used.

3.2.2.3 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.

c. Greater Than 600 Volt: Cable splices shall be made in accordance with the cable manufacturer's recommendations and Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3.2.2.4 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).
277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).

b. Conductor phase and voltage identification shall be made by

color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.

c. Control and signal circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors.

3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways shall be listed for the intended use when located in normally wet locations, when flush or surface mounted on outside of exterior surfaces. Boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA 4 or as shown. Boxes in other locations shall be sheet steel. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box

mounting brackets.

3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided.

3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

3.5 RECEPTACLES

3.5.1 Single and Duplex, 15 or 20-ampere, 125 volt

Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of brown. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

3.5.2 Weatherproof Applications

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Wet Locations". Assemblies shall be installed in accordance with the manufacturer's recommendations.

3.5.2.1 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in

use.

3.5.3 Special-Purpose or Heavy-Duty Receptacles

Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking type receptacles, rated 30 amperes or less, shall be locked by rotating the plug. Locking type receptacles, rated more than 50 amperes, shall utilize a locking ring.

3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall be brown. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere -volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red. Dimming switches shall be solid-state flush mounted, sized for the loads.

3.7 SERVICE EQUIPMENT

Service-disconnecting means shall be of the type indicated with an external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

3.8 PANELBOARDS

Circuit breakers and switches used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper .

3.8.1 Panelboards

Panelboards shall be circuit breaker or fusible switch equipped as indicated on the drawings.

3.9 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits and exterior communications conduits. Underground service lateral conductors will be extended to building service entrance and terminated in accordance with the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND and NFPA 70.

3.10 MOTOR CONTROL

Each motor or group of motors requiring a single control shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control; when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3.10.1 Reduced-Voltage Controllers

Reduced-voltage controllers shall be provided for polyphase motors 100 hp or larger. Reduced-voltage starters shall be of the single-step autotransformer, reactor, or resistor type having an adjustable time interval between application of reduced and full voltages to the motors. Wye-delta reduced voltage starters or part winding increment starters having an adjustable time delay between application of voltage to first and second winding of motor may be used in lieu of the reduced voltage starters specified above for starting of motor-generator sets, centrifugally operated equipment or reciprocating compressors provided with automatic unloaders.

3.10.2 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

3.11 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by

NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3.12 TRANSFORMER INSTALLATION

Three-phase transformers shall be connected only in a delta-wye or wye-delta configuration as indicated.

3.13 LIGHTING FIXTURES, LAMPS AND BALLASTS

This paragraph shall cover the installation of lamps, lighting fixtures and ballasts in interior or building mounted applications.

3.13.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed just prior to project completion. Lamps installed and used for working light during construction shall be replaced prior to turnover to the Government if more than 15% of their rated life has been used. Lamps shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer. 10% spare lamps of each type, from the original manufacturer, shall be provided.

3.13.2 Lighting Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on the drawings. Illustrations shown on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

3.13.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

3.13.2.2 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on or from the ceiling as shown. Installation and support of fixtures shall be in accordance with NFPA 70 and manufacturer's recommendations. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Surface-mounted fixtures shall be suitable for fastening to the ceiling panel structural supports.

3.14 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements

of paragraph WIRING METHODS. Seal tight 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors.

3.14.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

3.14.2 Installation of Government-Furnished Equipment

Wiring shall be extended to the equipment and terminated.

3.15 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

3.16 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTING, GENERAL.

3.17 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3.18 FIELD TESTING

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.18.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.18.2 Ground-Resistance Tests

The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

a. Single rod electrode - [25 ohms] [_____].

3.18.3 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 48 hours before the site is ready for inspection.

3.18.4 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.18.4.1 Low Voltage Cable Tests

a. Continuity test.

b. Insulation resistance test.

3.18.5 Motor Tests

a. Phase rotation test to ensure proper directions.

b. Operation and sequence of reduced voltage starters.

c. High potential test on each winding to ground.

d. Insulation resistance of each winding to ground.

e. Vibration test.

f. Dielectric absorption test on motor [and starter].

3.18.6 Dry-Type Transformer Tests

The following field tests shall be performed on all dry-type transformers 10 kVA and above.

a. Insulation resistance test phase-to-ground, each phase.

b. Turns ratio test.

3.18.7 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.18.7.1 Circuit Breakers, Molded Case

a. Insulation resistance test phase-to-phase, all combinations.

b. Insulation resistance test phase-to-ground, each phase.

c. Closed breaker contact resistance test.

d. Manual operation of the breaker.

3.19 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3.20 FIELD SERVICE

3.20.1 Onsite Training

The Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate all routine maintenance operations.

3.20.2 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of equipment, assist in the performance of the onsite tests, oversee initial operations, and instruct personnel as to the operational and maintenance features of the equipment.

3.21 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation,

material or operation have been corrected.

-- End of Section --