



W912DQ-04-R-0016

**US Army Corps  
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Kansas City District  
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# **Airfield Improvements**

## **McConnell Air Force Base, Kansas**

**Volume 3: Frangible Structure Study**

**July 2004**

DEPARTMENT OF THE ARMY  
 Kansas City District, Corps of Engineers  
 757 Federal Building  
 Kansas City, Missouri 64106

SPECIFICATIONS FOR CONSTRUCTION OF  
 AIRFIELD IMPROVEMENTS  
 MCCONNELL AIR FORCE BASE, KANSAS

VOLUME 3

FRANGIBLE STRUCTURE STUDY

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DIVISION 2 - SITE WORK

02220 Demolition  
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## SECTION 02220

DEMOLITION  
09/03

## 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 NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A10.6 (1990; R 1998) Safety Requirements for  
Demolition Operations

## U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2003) Safety and Health Requirements Manual

## U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 61-SUBPART M National Emission Standard for Asbestos

## 1.2 GENERAL REQUIREMENTS

Do not begin demolition until authorization is received from the Contracting Officer. Remove rubbish and debris from the project site; do not allow accumulations on airfield pavements. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Rubbish and debris shall be removed from Government property daily, unless otherwise directed, to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Officer. In the interest of occupational safety and health, the work shall be performed in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections. In the interest of conservation, salvage shall be pursued to the maximum extent possible (in accordance with Section 01572 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT, if applicable; salvaged items and materials shall be disposed of as specified.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-07 Certificates

Demolition plan; G, RO

Notifications; G, RO

Submit proposed salvage, demolition and removal procedures to the Contracting Officer for approval before work is started.

#### SD-11 Closeout Submittals

##### Receipts

Receipts or bills of lading, as specified.

#### 1.4 REGULATORY AND SAFETY REQUIREMENTS

Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," safety requirements shall conform with ANSI A10.6.

##### 1.4.1 Notifications

###### 1.4.1.1 General Requirements

Furnish timely notification of demolition projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61-SUBPART M. Notify the Regional Office of the United States Environmental Protection Agency (USEPA) or State's environmental protection agency and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61-SUBPART M.

##### 1.4.2 Receipts

Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped to the Defense Depot, Richmond, Virginia.

#### 1.5 DUST AND DEBRIS CONTROL

Prevent the spread of dust and debris on airfield pavements and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to aircraft.

## 1.6 PROTECTION

### 1.6.1 Traffic Control Signs

Where aircraft safety is endangered in the area of removal work, use traffic barricades with flashing lights. Anchor barricades in a manner to prevent displacement by jet or prop blast. Notify the Contracting Officer prior to beginning such work.

- a. Barricades shall be low profile beam barricades, meeting the dimensions shown in the plans. Reflective material, orange florescent and white florescent diagonal shall be placed on all faces. Flashing lights shall be yellow and have a minimum of 5 candelas effective intensity and flash at a rate from 55 to 75 flashes per minute.
- b. The Contractor shall provide and post a sign at the access point saying "Authorized Personnel Only".
- c. The Contractor shall place guidance signs for his construction traffic as necessary.

### 1.6.2 Existing Work

Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government; any damaged items shall be repaired or replaced as approved by the Contracting Officer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload pavements. Provide new supports and reinforcement for existing construction weakened by demolition or removal work. Repairs, reinforcement, or structural replacement must have Contracting Officer approval.

### 1.6.3 Facilities

Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

### 1.6.4 Protection of Personnel

During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate

action to protect all personnel working in and around the demolition site.

#### 1.7 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

#### 1.8 FOREIGN OBJECT DAMAGE (FOD)

Aircraft and aircraft engines are subject to FOD from debris and waste material lying on airfield pavements. Remove all such materials that may appear on operational aircraft pavements due to the Contractor's operations. If necessary, the Contracting Officer may require the Contractor to install a temporary barricade at the Contractor's expense to control the spread of FOD potential debris. The barricade shall consist of a fence covered with a fabric designed to stop the spread of debris; anchor the fence and fabric to prevent displacement by winds or jet/prop blasts. Remove barricade when no longer required.

#### 1.9 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by the Contracting Officer.

#### 1.10 REQUIRED DATA

Demolition plan shall include procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a disconnection schedule of utility services, and airfield lighting, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. The procedures shall provide for safe conduct of the work in accordance with EM 385-1-1.

#### 1.11 ENVIRONMENTAL PROTECTION

The work shall comply with the requirements of Section 01355A ENVIRONMENTAL PROTECTION.

#### 1.12 USE OF EXPLOSIVES

Use of explosives will not be permitted.

#### 1.13 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available as indicated in the project drawings.

### PART 2 PRODUCTS

Not used.

### PART 3 EXECUTION

#### 3.1 EXISTING FACILITIES TO BE REMOVED

##### 3.1.1 Utilities and Related Equipment

Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions of the Contracting Officer. If utility lines are encountered that are not shown on drawings, contact the Contracting Officer for further instructions.

##### 3.1.2 Paving and Slabs

Remove concrete and asphaltic concrete paving and slabs including aggregate base as shown in the plans, to the depth shown in the plans, but to a depth not less than 4 inches below new finish grade. Provide neat sawcuts at limits of pavement removal as specified in Section 02575 PAVEMENT REMOVAL.

#### 3.2 DISPOSITION OF MATERIAL

##### 3.2.1 Title to Materials

Except where specified in other sections, all materials and equipment removed, and not reused, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition and removal procedures, and authorization by the Contracting Officer to begin demolition. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Materials and equipment shall not be viewed by prospective purchasers or sold on the site.

### 3.2.2 Reuse of Materials and Equipment

Remove and store materials and equipment to be reused or relocated to prevent damage, and reinstall as the work progresses.

### 3.2.3 Salvaged Materials and Equipment

Remove materials and equipment that are to be removed by the Contractor and that are to remain the property of the Government, and deliver to a storage site designed by the Contracting Officer.

Contractor shall salvage items and material to the maximum extent possible.

Material salvaged for the Contractor shall be stored as approved by the Contracting Officer and shall be removed from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

Salvaged items to remain the property of the Government shall be removed in a manner to prevent damage, and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage shall be repaired or replaced to match existing items. Containers shall be properly identified as to contents. The following items reserved as property of the Government shall be delivered to the areas designated:

- Airfield Lighting Edge Light Fixtures - not reinstalled at new locations
- Transformers
- Light Bases
- Hand hole lids - not reinstalled at new locations.

The following items reserved as property of the using service shall be removed prior to commencement of work under this contract. Historical items shall be removed in a manner to prevent damage. The following historical items shall be delivered to the Government for disposition: Corner stones, contents of corner stones, and document boxes wherever located on the site.

### 3.3.4 Unsalvageable Material

Concrete, asphalt, masonry, and other noncombustible material, except concrete permitted to remain in place, shall become the property of the Contractor and disposed of off the site with the following exceptions: Concrete may be reused as crushed recycled concrete as specified, providing it meets all the requirements of the specification. Concrete and asphalt less than 1-1/2 inch in diameter, may be spread, graded and compacted on the Contractor's haul roads, to the extent practical, as directed by the Contracting Officer. Concrete and asphalt not reused shall be disposed of off airport property.

### 3.3 CLEANUP

Debris and rubbish shall be removed from demolition and excavations. Debris shall be removed and transported in a manner that prevents

spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

-- End of Section --



## SECTION 02300

EARTHWORK  
08/03

## 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 T 180 (2001) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
- AASHTO T 224 (2001) Correction for Coarse Particles in the Soil Compaction Test

## AMERICAN WATER WORKS ASSOCIATION (AWWA)

- AWWA C600 (1999) Installation of Ductile-Iron Water Mains and Their Appurtenances

## ASTM INTERNATIONAL (ASTM)

- ASTM C 136 (2001) Sieve Analysis of Fine and Coarse Aggregates
- ASTM C 33 (2003) Concrete Aggregates
- ASTM D 1140 (2000) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
- ASTM D 1556 (2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
- ASTM D 1557 (2002) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
- ASTM D 2167 (1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- ASTM D 2487 (2000) Soils for Engineering Purposes (Unified Soil Classification System)
- ASTM D 2922 (2001) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- ASTM D 3017 (2001) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 422 (1963; R 2002) Particle-Size Analysis of Soils

ASTM D 4318 (2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM D 698 (2000a) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 530/F-93/004 (1993; Rev 0; Updates I, II, IIA, IIB, and III) Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)

EPA 600/4-79/020 (1983) Methods for Chemical Analysis of Water and Wastes

1.2 DEFINITIONS

1.2.1 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, CL, ML, CL-ML.

1.2.2 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.

### 1.2.3 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.

### 1.2.4 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 1557 abbreviated 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.

### 1.2.5 Topsoil

Material suitable for topsoils obtained from offsite areas or excavations is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than 25 mm one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

### 1.2.6 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

#### 1.2.7.1 General Requirements

Select granular material shall consist of materials classified as GW, GP, SW, SP, or by ASTM D 2487 where indicated.

### 1.2.8 Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 3 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 3 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality

Control approval. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Dewatering Work Plan; G

SD-03 Product Data

Utilization of Excavated Materials; G

Shoulder Construction

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  
Borrow Site Testing

Within 24 hours of conclusion of physical tests, 6 copies of test results, including calibration curves and results of calibration tests. Results of testing at the borrow site.

SD-07 Certificates

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

1.4 CLASSIFICATION OF EXCAVATION

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

1.5 CRITERIA FOR BIDDING

Base bids on the following criteria:

- a. Surface elevations are as indicated.

1.6 DEWATERING WORK PLAN

Submit procedures for accomplishing dewatering work.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Offsite soils brought in for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCPL test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA 530/F-93/004 Method 5030/8020. TCLP shall be performed in accordance with EPA 530/F-93/004 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Material shall not be brought on site until tests have been approved by the Contracting Officer.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

Polyethylene plastic and 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, 75 mm 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]
	[Yellow:]	[Gas, Oil;
Dangerous Materials]	[Orange:]	[Telephone and
Other		
Communications]	[Blue:]	[Water Systems]
	[Green:]	[Sewer Systems]
	[White:]	[Steam Systems]
	[Gray:]	[Compressed Air]

2.2.1 Warning Tape for Metallic Piping

Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

#### 2.2.2 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.

#### 2.3 DETECTION WIRE FOR NON-METALLIC PIPING

Detection wire shall be insulated single strand, solid copper with a minimum of 12 AWG.

### PART 3 EXECUTION

#### 3.1 STRIPPING OF TOPSOIL

Under all new airfield pavements, including shoulders, and where indicated or directed, topsoil shall be stripped to a depth of 4 inches. Topsoil shall be spread on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil shall be kept separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 50 mm 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Any surplus of topsoil from excavations and grading shall be removed from the site.

#### 3.2 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.

#### 3.2.1 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.

#### 3.2.2 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.

#### 3.2.3 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. The Contractor shall establish/construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

#### 3.2.4 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. 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.

### 3.2.5 Trench Excavation Requirements

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. The Contractor shall shore trench walls as appropriate to meet applicable safety standards. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter and shall not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

#### 3.2.5.1 Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

#### 3.2.5.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 4 inches below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

### 3.2.5.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

### 3.2.5.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be sufficient to leave at least 12 inches clear between the outer structure surfaces and the face of the excavation or support members. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

### 3.2.5.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, excavation shall be by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.

### 3.2.6 Underground Utilities

Prior to the start of any utility excavation, the Contractor shall obtain a dig permit from McConnell AFB Base CE. 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 200 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.

## 3.3 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. 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.

#### 3.4 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

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.

#### 3.5 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. Stockpiles of satisfactory and unsatisfactory shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources.

#### 3.6 GROUND SURFACE PREPARATION

##### 3.6.1 General Requirements

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill.

##### 3.6.2 Frozen Material

Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Minimum subgrade density shall be as specified in paragraph TESTING.

### 3.7 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.

### 3.8 BURIED TAPE AND DETECTION WIRE

#### 3.8.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

#### 3.8.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over its entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

### 3.9 BACKFILLING AND COMPACTION

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; and Section 02300 EARTHWORK. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

### 3.9.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall be backfilled to 2 feet above the top of pipe prior to performing the required pressure tests. The joints and couplings shall be left uncovered during the pressure test.

#### 3.9.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.

#### 3.9.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 150 mm 6 inches loose thickness.

#### 3.9.1.3 Bedding and Initial Backfill

Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D 698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide materials as follows:

- a. Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as aggregate separation layer in accordance with Section 02176 or having a classification of GW or GP in accordance with ASTM D 2487 for bedding and backfill as indicated. Maximum particle size shall not exceed 3 inches.

#### 3.9.1.4 Final Backfill

The remainder of the trench, except for special materials for roadways, railroads and airfields, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

- a. Roadways, Railroads, and Airfields: Backfill shall be placed up to the required elevation as specified. Water flooding or jetting methods of compaction will not be permitted.

b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 300 mm 12 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

### 3.9.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

### 3.10 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

#### 3.10.1 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated. Special trenching requirements for direct-burial electrical cables and conduits are specified in Section 16526A AIRFIELD AND HELIPORT LIGHTING AND VISUAL NAVIGATION AIDS.

### 3.11 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. Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work, shall be repaired and grades re-established to the required elevations and slopes.

#### 3.11.1 Subgrade and Embankments

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.

### 3.12 PLACING TOPSOIL

On areas to receive topsoil, the compacted subgrade soil shall be scarified to a 2 inch depth for bonding of topsoil with subsoil. Topsoil then shall be spread evenly to a thickness of 4 inches and graded to the elevations and slopes shown. Topsoil shall not be spread when frozen or excessively wet or dry. Material required for topsoil in excess of that produced by excavation within the grading limits shall be obtained from offsite areas.

### 3.13 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 1556 and ASTM D 2167. 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.

#### 3.13.1 Fill and Backfill Material Gradation

One test per 10,000 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.

#### 3.13.2 In-Place Densities

- b. One test per 100 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

#### 3.13.3 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.

#### 3.13.4 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 5,000 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

#### 3.14.6 Tolerance Tests for Subgrades

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

#### 3.15 DISPOSITION OF SURPLUS MATERIAL

Surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber shall be removed from Government property as directed by the Contracting Officer.

-- End of Section --



## SECTION 02373

SITE CONSTRUCTION  
GEOTEXTILE

09/03

## 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.

## ASTM INTERNATIONAL (ASTM)

ASTM D 4491	(1999a) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(1991; R 1996) Trapezoid Tearing Strength of Geotextiles
ASTM D 4873	(2002) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

## 1.2 SUBMITTALS

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

## SD-03 Product Data

## Manufacturing Quality Control Sampling and Testing

A minimum of seven [7] days prior to scheduled use, manufacturer's quality control manual.

## SD-04 Samples

## Quality Assurance Samples and Tests

Samples for quality assurance testing; seven [7] days shall be allotted in the schedule to allow for testing.

## SD-07 Certificates

## Geotextile

A minimum of seven [7] days prior to scheduled use, manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, the manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

#### 1.5 DELIVERY, STORAGE AND HANDLING

Delivery, storage, and handling of geotextile shall be in accordance with ASTM D 4873.

##### 1.5.1 Delivery

The Contracting Officer shall be notified a minimum of 24 hours prior to delivery and unloading of geotextile rolls. Rolls shall be packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, rolls shall be immediately rewrapped with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Each roll shall be labeled with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

##### 1.5.2 Storage

Rolls of geotextile shall be protected from construction equipment, chemicals, sparks and flames, temperatures in excess of 71 degrees C 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, rolls shall either be elevated off the ground or placed on a sacrificial sheet of plastic in an area where water will not accumulate.

##### 1.5.3 Handling

Geotextile rolls shall be handled and unloaded with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

#### PART 2 PRODUCTS

##### 2.1 RAW MATERIALS

###### 2.1.1 Geotextile

Geotextile shall be a woven pervious sheet of polymeric material and shall consist of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a

flat, tape-like character) will not be allowed. Stabilizers and/or inhibitors shall be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile.

Post-consumer recycled material shall not be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Geotextiles shall meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 1  
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
GRAB STRENGTH 4632	N	700	ASTM D
SEAM STRENGTH ASTM D 4632	N	[ _____ ]	
PUNCTURE ASTM D 4833	N	250	
TRAPEZOID TEAR 4533	N	250	ASTM D
APPARENT OPENING SIZE ASTM D 4751	U.S. SIEVE		
PERMITTIVITY ASTM D 4491	SEC -1		
ULTRAVIOLET DEGRADATION	PERCENT	50 AT 500 HRS	ASTM D 4355

TABLE 1 (Continued)

MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
GRAB STRENGTH ASTM D 4632	LBS	[160][_____]	
SEAM STRENGTH ASTM D 4632	LBS	[_____]	
PUNCTURE ASTM D 4833	LBS	[55][_____]	
TRAPEZOID TEAR ASTM D 4533	LBS	[55][_____]	
APPARENT OPENING SIZE ASTM D 4751	U.S. SIEVE	[_____]	
PERMITTIVITY ASTM D 4491	SEC -1	[_____]	
ULTRAVIOLET DEGRADATION	PERCENT	50 AT 500 HRS	ASTM D 4355

2.1.2 Thread

Sewn seams shall be constructed with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile.

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer shall be responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Manufacturing quality control sampling and testing shall be performed in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D 4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D 4759. Tests not meeting the specified requirements shall result in the rejection of applicable rolls.

## PART 3 EXECUTION

### 3.1 QUALITY ASSURANCE SAMPLES AND TESTS

#### 3.1.1 Quality Assurance Samples

The Contractor shall provide assistance to the Contracting Officer in the collection of quality assurance samples. Samples shall be collected upon delivery to the site for quality assurance testing at the request of the Contracting Officer. Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size shall be considered one roll of geotextile. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. The outer layer of the geotextile roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

### 3.2 INSTALLATION

#### 3.2.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with existing materials found at the site.

#### 3.2.2 Placement

The Contractor shall notify the Contracting Officer a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, the geotextile shall be laid with the machine direction of the fabric parallel to the slope direction.

### 3.3 SEAMS

#### 3.3.1 Overlap Seams

Geotextile panels shall be continuously overlapped a minimum of 12 inches at all longitudinal and transverse joints. Where seams must be oriented across the slope, the upper panel shall be lapped over the lower panel.

### 3.4 PROTECTION

The geotextile shall be protected during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Adequate ballast (e.g. sand bags) shall be used

to prevent uplift by wind. The geotextile shall not be left uncovered for more than fourteen [14] days after installation.

### 3.5 REPAIRS

Torn or damaged geotextile shall be repaired. Clogged areas of geotextile shall be removed. Repairs shall be performed by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 300 mm 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Geotextile rolls which cannot be repaired shall be removed and replaced. Repairs shall be performed at no additional cost to the Government.

### 3.6 COVERING

Geotextile shall not be covered prior to inspection and approval by the Contracting Officer. Cover soil shall be placed in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, soil backfill shall be placed from the bottom of the slope upward. Cover soil shall not be dropped onto the geotextile from a height greater than 3 feet. No equipment shall be operated directly on top of the geotextile without approval of the Contracting Officer. Equipment with ground pressures less than 7 psi shall be used to place the first lift over the geotextile. A minimum of twelve [12] inches of soil shall be maintained between full-scale construction equipment and the geotextile. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

-- End of Section --

## SECTION 02821A

FENCING  
04/04

## 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.

## ASTM INTERNATIONAL (ASTM)

ASTM A 121	(1999) Metallic-Coated Carbon Barbed Wire
ASTM A 153/A 153M	(2003) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 392	(2003) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 491	(2003) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 585	(1997) Aluminum-Coated Steel Barbed Wire **
ASTM A 780	(2001) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(2001) Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link Fence
ASTM C 94/C 94M	(2003a) Ready-Mixed Concrete
ASTM F668	(1996) Poly (Vinyl Chloride) (PVC)-Coated Steel Chain-Link Fence Fabric
ASTM F 1043	(2000) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997; R 2003) Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(2003) Industrial and Commercial Horizontal Slide Gates
ASTM F 626	(1996a; R 2003) Fence Fittings
ASTM F 900	(2003) Industrial and Commercial Swing Gates

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-07 Certificates

#### Chain Link Fence; G

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials meet the specified requirements.

## PART 2 PRODUCTS

### 2.1 FENCE FABRIC

Fence fabric shall conform to the following:

#### 2.1.1 Chain Link Fence Fabric

ASTM F668, Class 2a, poly vinyl chloride coated over zinc-coated steel wire with minimum coating thickness of 1.5 mil. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

### 2.2 POSTS

#### 2.2.1 Metal Posts for Chain Link Fence

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe, shall meet the strength and coating requirements of ASTM F 1043. Sizes shall be as shown on the drawings. Line posts and terminal (corner and pull) posts selected shall be of the same designation throughout the fence.

### 2.3 BRACES AND RAILS

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4 zinc-coated, shall meet the strength and coating requirements of ASTM F 1043.

## 2.4 WIRE

### 2.4.1 Barbed Wire

Barbed wire shall conform to ASTM A 121 zinc-coated, Class 3, 12.5 guage wire with 14 guage, 4-point barbs spaced no more than 5 inches apart.

## 2.5 ACCESSORIES

ASTM F 626. Ferrous accessories shall be pvc coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire support arms shall be the single arm type and of the design required for the post furnished. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. Tie wires for attaching fabric to tension wire on high security fences shall be 1.6 mm 16 gage stainless steel. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified.

## 2.6 CONCRETE

ASTM C 94/C 94M, using 3/4 inch maximum size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780. Damage to PVC finish shall be repaired to match original condition.

### 3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a 1 inch clearance between the bottom of the fabric and finish grade.

### 3.3 POST INSTALLATION

#### 3.3.1 Posts for Chain Link Fence

Posts shall be set plumb and in alignment. Floor flange shall be fastened to concrete piers with expansion bolts. Frangible coupling

shall be fully engaged to floor flange. Posts shall be bolted to frangible coupling. Concrete shall be allowed to cure for 72 hours prior to attachment of any item to the posts.

### 3.4 RAILS

#### 3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Top rail shall be installed as indicated on the drawings.

#### 3.4.2 Bottom Rail

The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts using sleeves or couplings. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

### 3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as required and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 6 feet in height. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal.

### 3.6 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15 inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 12 inch intervals and fastened to all rails at approximately 12 inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be plus or minus 1 inch above the ground.

### 3.7 BARBED WIRE SUPPORTING ARMS AND BARBED WIRE

#### 3.7.1 General Requirements

Barbed wire supporting arms and barbed wire shall be installed as indicated and as recommended by the manufacturer. Supporting arms shall be anchored 3/8 inch diameter plain pin rivets or, at the Contractor's option, with 3/8 inch diameter set bolts. A minimum of two studs per support arm shall be used. Barbed wire shall be pulled taut and attached to the arms with clips or other means that will prevent easy removal.

-- End of Section -



## SECTION 02921

SEEDING  
05/04

## 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.

## ASTM INTERNATIONAL

ASTM C 602	(1995a; R 2001) Agricultural Liming Materials
ASTM D 4972	(2001) pH of Soils
ASTM D 5283	(1996; R 2002) Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes

## U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R1998) Federal Seed Act
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## 1.2 SUBMITTALS

## 1.3 DELIVERY, 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 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

## 1.3.1.2 Topsoil

Prior to delivery of any topsoil, its availability shall be verified in paragraph TOPSOIL. A soil test shall be provided for topsoil delivered to the site.

## 1.3.1.3 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.

#### 1.3.1.4 Handling

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

#### 1.3.1.5 Time Limitations

Hydroseeding time limitation for holding seed in the slurry shall be a maximum 24 hours. .

### PART 2 PRODUCTS

#### 2.1 SEED

##### 2.1.1 Classification

Provide State-certified seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws.

#### 2.2 TOPSOIL

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the seed specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 1-1/2 inch diameter. Topsoil shall be free from viable plants and plant parts.

#### 2.3 FERTILIZER

##### 2.3.1 Granular Fertilizer

Synthetic, granular controlled release fertilizer formulated for existing conditions and grasses.

#### 2.4 MULCH

Mulch shall be free from noxious weeds, mold, and other deleterious materials.

##### 2.4.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contain no fertile seed.

##### 2.4.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay shall be sterile, containing no fertile seed.

#### 2.4.3 Wood Cellulose Fiber Mulch

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: 9 to 15 percent moisture, pH range from 4.5 to 6.0.

#### 2.5 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life.

## 2.6 SURFACE EROSION CONTROL MATERIAL

Erosion control material shall conform to the following:

### 2.6.1 Surface Erosion Control Blanket

Blanket shall be machine produced mat of wood excelsior formed from a web of interlocking wood fibers; covered on one side with either knitted straw blanket-like mat construction; covered with biodegradable plastic mesh; or interwoven biodegradable threat, plastic netting, or twisted kraft paper cord netting.

### 2.6.2 Surface Erosion Control Fabric

Fabric shall be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips shall have a minimum life of 6 months.

### 2.6.3 Surface Erosion Control Net

Net shall be heavy, twisted jute mesh, weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately 1 inch square.

### 2.6.4 Surface Erosion Control Chemicals

Chemicals shall be high-polymer synthetic resin or cold-water emulsion of selected petroleum resins.

### 2.6.5 Surface Hydrophilic Colloids

Hydrophilic colloids shall be physiologically harmless to plant and animal life without phytotoxic agents. Colloids shall be naturally occurring, silicate powder based, and shall form a water insoluble membrane after curing. Colloids shall resist mold growth.

### 2.6.6 Erosion Control Material Anchors

Erosion control anchors shall be as recommended by the manufacturer.

## PART 3 EXECUTION

### 3.1 PREPARATION

#### 3.1.1 EXTENT OF WORK

Provide soil preparation (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

##### 3.1.1.1 Topsoil

Provide topsoil to meet indicated finish grade as shown on drawings. After areas have been brought to indicated finish grade, incorporate

fertilizer into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 19 mm 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

#### 3.1.1.2 Fertilizer Application Rates

Apply fertilizer at rates as instructed by the manufacture. For bidding purposes only apply at rates for the following:

Granular Fertilizer [[\_\_\_\_\_] kg per square meter[\_\_\_\_\_] pounds per acre] [[\_\_\_\_\_] kg per 100 square meters[\_\_\_\_\_] pounds per 1000 square feet.]]

[Synthetic Fertilizer [ [\_\_\_\_\_] kg per square meter[\_\_\_\_\_] pounds per acre ] [[\_\_\_\_\_] kg per 100 square meters[\_\_\_\_\_] pounds per 1000 square feet.]]

[Hydroseeding Fertilizer [[\_\_\_\_\_] kg per square meter[\_\_\_\_\_] pounds per acre] [[\_\_\_\_\_] kg per 100 square meters[\_\_\_\_\_] pounds per 1000 square feet.]]

### 3.2 SEEDING

#### 3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy [frozen] [snow covered] or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

#### 3.2.2 Seed Application Method

Seeding method shall be [broadcasted and drop seeding][drill seeding][hydroseeding].

##### 3.2.2.1 Broadcast and Drop Seeding

Seed shall be uniformly broadcast at the rate of [\_\_\_\_\_]kilograms per hectarepounds per 1000 square feet. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of [6] [\_\_\_\_\_] mm 1/4 inch in clay soils and [13] [\_\_\_\_\_] mm [1/2] [\_\_\_\_\_] inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

##### 3.2.2.2 Drill Seeding

Seed shall be drilled at the rate of [\_\_\_\_\_]kilograms per hectarepounds per 1000 square feet. Use [cultipacker seeders] [grass seed drills] [\_\_\_\_\_] . Drill seed uniformly to average depth of [13] [\_\_\_\_\_] mm [1/2] [\_\_\_\_\_] inch.

#### 3.2.2.3 Hydroseeding

First, mix water and fiber. Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. Fiber shall be added at 1,000 pounds, dry weight, per acre 11.2 kg per 100 square meter. Then add and mix seed and fertilizer to produce a homogeneous slurry. Seed shall be mixed to ensure broadcasting at the rate of [\_\_\_\_\_]kilograms per hectarepounds per 1000 square feet. When hydraulically sprayed on the ground, material shall form a blotter like cover impregnated uniformly with grass seed. Spread with one application with no second application of mulch.

#### 3.2.3 Mulching

##### 3.2.3.1 Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 0.75 metric tons per hectare 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

##### 3.2.3.2 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.

##### 3.2.3.3 Asphalt Adhesive Tackifier

Asphalt adhesive tackifier shall be sprayed at a rate between 666 to 866 liters per hectare 10 to 13 gallons per 1000 square feet. Sunlight shall not be completely excluded from penetrating to the ground surface.

#### 3.2.3.4 Non-Asphaltic Tackifier

Hydrophilic colloid shall be applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. A uniform mixture shall be applied over the area.

#### 3.2.3.5 Asphalt Adhesive Coated Mulch

Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 666 to 866 liters per hectare 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.

#### 3.2.4 Rolling

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding [134] [\_\_\_\_\_] kg per m [90] [\_\_\_\_\_] pounds for each foot of roller width. [If seeding is performed with cultipacker-type seeder or by hydroseeding, rolling may be eliminated.]

#### 3.2.5 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

#### 3.2.6 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of [50] [\_\_\_\_\_] mm [2] [\_\_\_\_\_] inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

### 3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

### 3.4 RENOVATION OF EXISTING TURF AREA

#### 3.4.1 Aeration

Upon completion of weed eradication operations and Contracting Officer's approval to proceed, aerate turf areas indicated, by approved device. Core, by pulling soil plugs, to a minimum depth of [\_\_\_\_\_] mm [\_\_\_\_\_] inches. [Leave all soil plugs, that are produced, in the turf area.] [Remove all debris generated during this operation off site.] [After aeration operations are complete, topdress entire area [6.35 mm1/4 inch] [12.70 mm1/2 inch] depth with the following mixture:

[[\_\_\_\_\_] percent sand]  
[[\_\_\_\_\_] percent humus]  
[[\_\_\_\_\_] percent gypsum]  
[[\_\_\_\_\_] percent organic fertilizer]

[[\_\_\_\_\_] percent synthetic fertilizer]

Blend all parts of topdressing mixture to a uniform consistency throughout.] Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean all soil plugs off of other paving when work is complete.

#### 3.4.2 Vertical Mowing

Upon completion of aerating operation and Contracting Officer's approval to proceed, vertical mow turf areas indicated, by approved device, to a depth of [6 mm/4 inch] [13 mm/2 inch] above existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.

#### 3.4.3 Dethatching

Upon completion of aerating operation and Contracting Officer's approval to proceed, dethatch turf areas indicated, by approved device, to a depth of [6 mm/4 inch] [13 mm/2 inch] below existing soil level, to reduce thatch build-up, grain, and surface compaction. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work is complete. Remove all debris generated during this operation off site.

#### 3.4.4 Overseeding

Apply seed in accordance with applicable portions of paragraph entitled "Seed Application Method" at rates in accordance with paragraph entitled "Seed Composition."

#### 3.5 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section -



DIVISION 3 - CONCRETE

03307A Concrete for Minor Structures

## SECTION 03307A

CONCRETE FOR MINOR STRUCTURES  
11/01

## 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.

## ACI INTERNATIONAL (ACI)

- ACI 308 (2001) Guide to Curing Concrete  
ACI 347R (2001) Guide to Formwork for Concrete

## ASTM INTERNATIONAL (ASTM)

- ASTM A 185 (2002) Steel Welded Wire Reinforcement, Plain, for Concrete  
ASTM A 615/A 615M (2003a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement  
ASTM C 143/C 143M (2003) Slump of Hydraulic Cement Concrete  
ASTM C 150 (2002ae1) Portland Cement  
ASTM C 171 (2003) Sheet Materials for Curing Concrete  
ASTM C 172 (1999) Sampling Freshly Mixed Concrete  
ASTM C 231 (2003) Air Content of Freshly Mixed Concrete by the Pressure Method  
ASTM C 260 (2001) Air-Entraining Admixtures for Concrete  
ASTM C 309 (2003) Liquid Membrane-Forming Compounds for Curing Concrete  
ASTM C 31/C 31M (2003a) Making and Curing Concrete Test Specimens in the Field  
ASTM C 39/C 39M (2003) Compressive Strength of Cylindrical Concrete Specimens  
ASTM C 494/C 494M (1999ae1) Chemical Admixtures for Concrete

ASTM C 618	(2003) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 685	(2000) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 920	(2002) Elastomeric Joint Sealants
ASTM C 94/C 94M	(2003a) Ready-Mixed Concrete
ASTM D 1752	(1984; R 1996e1) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 75	(2003) Sampling Aggregates

## U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 572	(1974) Specifications for Polyvinylchloride Waterstops

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-03 Product Data

Air-Entraining Admixture; G  
Water-Reducing or Retarding Admixture; G  
Curing Materials; G  
Reinforcing Steel; G  
Expansion Joint Filler Strips, Premolded; G  
Joint Sealants - Field Molded Sealants; G  
Waterstops; G

Manufacturer's literature is available from suppliers which demonstrates compliance with applicable specifications for the above materials.

Batching and Mixing Equipment; G

Batching and mixing equipment will be accepted on the basis of manufacturer's data which demonstrates compliance with the applicable specifications.

Conveying and Placing Concrete;

The methods and equipment for transporting, handling, depositing, and consolidating the concrete shall be submitted prior to the first concrete placement.

Formwork; G

Formwork design shall be submitted prior to the first concrete placement.

#### SD-06 Test Reports

Aggregates; G

Aggregates will be accepted on the basis of certificates of compliance and test reports that show the material(s) meets the quality and grading requirements of the specifications under which it is furnished.

Concrete Mixture Proportions; G

Ten days prior to placement of concrete, the contractor shall submit the mixture proportions that will produce concrete of the quality required. Applicable test reports shall be submitted to verify that the concrete mixture proportions selected will produce concrete of the quality specified.

#### SD-07 Certificates

Cementitious Materials; G

Certificates of compliance attesting that the concrete materials meet the requirements of the specifications shall be submitted in accordance with the Special Clause "CERTIFICATES OF COMPLIANCE". Cementitious material will be accepted on the basis of a manufacturer's certificate of compliance, accompanied by mill test reports that the material(s) meet the requirements of the specification under which it is furnished.

Aggregates; G

Aggregates will be accepted on the basis of certificates of compliance and tests reports that show the material(s) meet the quality and grading requirements of the specifications under which it is furnished.

### 1.3 DESIGN AND PERFORMANCE REQUIREMENTS

The Government will maintain the option to sample and test joint sealer, joint filler material, waterstop, aggregates and concrete to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary to assist the Government in 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. Slump and air content will be determined in accordance with ASTM

C 143/C 143M and ASTM C 231, respectively, when cylinders are molded. Compression test specimens will be made, cured, and transported in accordance with ASTM C 31/C 31M. Compression test specimens will be tested in accordance with ASTM C 39/C 39M. Samples for strength tests will be taken not less than once each shift in which concrete is produced from each class of concrete required. A minimum of three specimens will be made from each sample; two will be tested at 28 days (90 days if pozzolan is used) for acceptance, and one will be tested at 7 days for information.

#### 1.3.1 Strength

Acceptance test results will be the average strengths of two specimens tested at 28 days (90 days if pozzolan is used). The strength of the concrete will be considered satisfactory so long as the average of three consecutive acceptance test results equal or exceed the specified compressive strength,  $f'c$ , and no individual acceptance test result falls below  $f'c$  by more than 500 psi.

#### 1.3.2 Construction Tolerances

A Class "C" finish shall apply to all surfaces except those specified to receive a Class "D" finish. A Class "D" finish shall apply to all surfaces which will be permanently concealed after construction. The surface requirements for the classes of finish required shall be as specified in ACI 347.

#### 1.3.3 Concrete Mixture Proportions

Concrete mixture proportions shall be the responsibility of the Contractor. Mixture proportions shall include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per cubic yard of concrete. All materials included in the mixture proportions shall be of the same type and from the same source as will be used on the project. Specified compressive strength  $f'c$  shall be 4000psi at 28 days (90 days if pozzolan is used). The maximum nominal size coarse aggregate shall be 1-1/2 inches, in accordance with ACI 318/318R. The air content shall be between 4.5 and 7.5 percent. The slump shall be between 2 and 5 inches. The maximum water cement ratio shall be 0.50.

#### 1.4 REGULATORY REQUIREMENTS

The state statutory and regulatory requirements listed below form a part of this specification to the extent referenced. Kansas Standard Specifications for Road and Bridge Construction, Class A Concrete (AE)

### PART 2 PRODUCTS

#### 2.1 MATERIALS

##### 2.1.1 Cementitious Materials

Cementitious materials shall conform to the appropriate specifications listed:

2.1.1.1 Portland Cement

ASTM C 150, Type I/II.

2.1.1.2 Pozzolan

Pozzolan shall conform to ASTM C 618, Class C or F, including requirements of Tables 1A and 2A.

2.1.2 Aggregates

Aggregates shall meet the quality and grading requirements of state highway department specification in accordance with paragraph REGULATORY REQUIREMENTS.

2.1.3 Admixtures

Admixtures to be used, when required or approved, shall comply with the appropriate specification listed. 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 at the request of the Contracting Officer and shall be rejected if test results are not satisfactory.

#### 2.1.3.1 Air-Entraining Admixture

Air-entraining admixture shall meet the requirements of ASTM C 260.

#### 2.1.3.2 Water-Reducing or Retarding Admixture

Water-reducing or retarding admixture shall meet the requirements of ASTM C 494/C 494M, Type A, B, or D. High-range water reducing admixture Type F or G may be used only when approved, approval being contingent upon particular placement requirements as described in the Contractor's Quality Control Plan.

#### 2.1.4 Water

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

#### 2.1.5 Reinforcing Steel

Reinforcing steel bar shall conform to the requirements of ASTM A 615/A 615M, Grade 60. Welded steel wire fabric shall conform to the requirements of ASTM A 185. Details of reinforcement not shown shall be in accordance with ACI 318M/318RM, ACI 318/318R, Chapters 7 and 12.

#### 2.1.6 Expansion Joint Filler Strips, Premolded

Expansion joint filler strips, premolded shall be sponge rubber conforming to ASTM D 1752, Type I.

#### 2.1.7 Joint Sealants - Field Molded Sealants

Joint sealants - field molded sealants shall conform to ASTM C 920, Type M, Grade NS, Class 25, use NT for vertical joints and Type M, Grade P, Class 25, use T for horizontal joints. Bond-breaker material shall be polyethylene tape, coated paper, metal foil, or similar type materials. The backup material shall be compressible, nonshrink, nonreactive with the sealant, and a nonabsorptive material such as extruded butyl or polychloroprene foam rubber. Immediately prior to installation of field-molded sealants, the joint shall be cleaned of all debris and further cleaned using water, chemical solvents, or other means as recommended by the sealant manufacturer or directed.

#### 2.1.8 Formwork

The design and engineering of the formwork as well as its construction, shall be the responsibility of the Contractor.

#### 2.1.9 Form Coatings

Forms for exposed surfaces shall be coated with a nonstaining form oil, which shall be applied shortly before concrete is placed.

#### 2.1.10 Curing Materials

Curing materials shall conform to the following requirements.

#### 2.1.10.1 Impervious Sheet Materials

Impervious sheet materials, ASTM C 171, type optional, except polyethylene film, if used, shall be white opaque.

#### 2.1.10.2 Membrane-Forming Curing Compound

ASTM C 309, Type 1-D or 2, Class A.

#### 2.1.10.3 Color

Concrete for encasing airfield electrical ducts shall be dyed red.

### PART 3 EXECUTION

#### 3.1 PREPARATION

##### 3.1.1 General

Construction joints shall be prepared to expose coarse aggregate, and the surface shall be clean, damp, and free of laitance. Ramps and walkways, as necessary, shall be constructed to allow safe and expeditious access for concrete and workmen. Snow, ice, standing or flowing water, loose particles, debris, and foreign matter shall have been removed. Earth foundations shall be satisfactorily compacted. Spare vibrators shall be available. The entire preparation shall be accepted by the Government prior to placing.

##### 3.1.2 Embedded Items

Reinforcement shall be secured in place; joints, anchors, and other embedded items shall have been positioned. Internal ties shall be arranged so that when the forms are removed the metal part of the tie will be not less than 50 mm 2 inches from concrete surfaces permanently exposed to view or exposed to water on the finished structures. Embedded items shall be free of oil and other foreign matters such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. All equipment needed to place, consolidate, protect, and cure the concrete shall be at the placement site and in good operating condition.

##### 3.1.3 Formwork Installation

Forms shall be properly aligned, adequately supported, and mortar-tight. The form surfaces shall be smooth and free from irregularities, dents, sags, or holes when used for permanently exposed faces. All exposed joints and edges shall be chamfered, unless otherwise indicated.

##### 3.1.4 Production of Concrete

###### 3.1.4.1 Ready-Mixed Concrete

Ready-mixed concrete shall conform to ASTM C 94/C 94M except as otherwise specified.

#### 3.1.4.2 Concrete Made by Volumetric Batching and Continuous Mixing

Concrete made by volumetric batching and continuous mixing shall conform to ASTM C 685.

#### 3.1.4.3 Batching and Mixing Equipment

The contractor shall have the option of using an on-site batching and mixing facility. The facility shall provide sufficient batching and mixing equipment capacity to prevent cold joints. The method of measuring materials, batching operation, and mixer shall be submitted for review. On-site plant shall conform to the requirements of Section 02753.

### 3.2 CONVEYING AND PLACING CONCRETE

Conveying and placing concrete shall conform to the following requirements.

#### 3.2.1 General

Concrete placement shall not be permitted when weather conditions prevent proper placement and consolidation without approval. When concrete is mixed and/or transported by a truck mixer, the concrete shall be delivered to the site of the work and discharge shall be completed within 1-1/2 hours or 45 minutes when the placing temperature is 85 degrees F or greater unless a retarding admixture is used. Concrete shall be conveyed from the mixer to the forms as rapidly as practicable by methods which prevent segregation or loss of ingredients. Concrete shall be in place and consolidated within 15 minutes after discharge from the mixer. Concrete shall be deposited as close as possible to its final position in the forms and be so regulated that it may be effectively consolidated in horizontal layers 18 inches or less in thickness with a minimum of lateral movement. The placement shall be carried on at such a rate that the formation of cold joints will be prevented.

#### 3.2.2 Consolidation

Each layer of concrete shall be consolidated by rodding, spading, or internal vibrating equipment. Internal vibration shall be systematically accomplished by inserting the vibrator through the fresh concrete in the layer below at a uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1.5 times the radius of action of the vibrator and overlay the adjacent, just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the layer below, if such a layer exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly at the rate of about 3 inches per second.

#### 3.2.3 Cold-Weather Requirements

No concrete placement shall be made when the ambient temperature is below 35 degrees F or if the ambient temperature is below 40 degrees F and falling. Suitable covering and other means as approved shall be

provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. Salt, chemicals, or other foreign materials shall not be mixed with the concrete to prevent freezing. Any concrete damaged by freezing shall be removed and replaced at the expense of the contractor.

#### 3.2.4 Hot-Weather Requirements

When the rate of evaporation of surface moisture, as determined by use of Figure 1 of ACI 308R, is expected to exceed 1 kilogram per square meter 0.2 pound per square foot per hour, provisions for windbreaks, shading, fog spraying, or 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.

### 3.3 FORM REMOVAL

Forms shall not be removed before the expiration of 24 hours after concrete placement except where otherwise specifically authorized. Supporting forms and shoring shall not be removed until the concrete has cured for at least 5 days. When conditions on the work are such as to justify the requirement, forms will be required to remain in place for longer periods.

### 3.4 FINISHING

#### 3.4.1 General

No finishing or repair will be done when either the concrete or the ambient temperature is below 50 degrees F.

#### 3.4.2 Finishing Formed Surfaces

All fins and loose materials shall be removed, and surface defects including tie holes shall be filled. All honeycomb areas and other defects shall be repaired. All unsound concrete shall be removed from areas to be repaired. Surface defects greater than 1/2 inch in diameter and holes left by removal of tie rods in all surfaces not to receive additional concrete shall be reamed or chipped and filled with dry-pack mortar. The prepared area shall be brush-coated with an approved epoxy resin or latex bonding compound or with a neat cement grout after dampening and filled with mortar or concrete. The cement used in mortar or concrete for repairs to all surfaces permanently exposed to view shall be a blend of portland cement and white cement so that the final color when cured will be the same as adjacent concrete.

#### 3.4.3 Finishing Unformed Surfaces

All unformed surfaces that are not to be covered by additional concrete or backfill shall be float finished to elevations shown, unless otherwise specified. Surfaces to receive additional concrete or backfill shall be brought to the elevations shown and left as a true and regular surface. Exterior surfaces shall be sloped for drainage unless otherwise shown. Joints shall be carefully made with a jointing tool. Unformed surfaces shall be finished to a tolerance

of 3/8 inch for a float finish and 5/16 inch for a trowel finish as determined by a 10 foot straightedge placed on surfaces shown on the plans to be level or having a constant slope. Finishing shall not be performed while there is excess moisture or bleeding water on the surface. No water or cement shall be added to the surface during finishing.

#### 3.4.3.1 Float Finish

Surfaces to be float finished shall be screeded and darbied or bullfloated to eliminate the ridges and to fill in the voids left by the screed. In addition, the darby or bullfloat shall fill all surface voids and only slightly embed the coarse aggregate below the surface of the fresh concrete. When the water sheen disappears and the concrete will support a person's weight without deep imprint, floating should be completed. Floating should embed large aggregates just beneath the surface, remove slight imperfections, humps, and voids to produce a plane surface, compact the concrete, and consolidate mortar at the surface.

#### 3.4.3.2 Expansion and Contraction Joints

Expansion and contraction joints shall be made in accordance with the details shown or as otherwise specified.

### 3.5 CURING AND PROTECTION

Beginning immediately after placement and continuing for at least 7 days, all concrete shall be cured and protected from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain or flowing water. All materials and equipment needed for adequate curing and protection shall be available and at the site of the placement prior to the start of concrete placement. Preservation of moisture for concrete surfaces not in contact with forms shall be accomplished by one of the following methods:

- a. Continuous sprinkling or ponding.
- b. Application of absorptive mats or fabrics kept continuously wet.
- c. Application of sand kept continuously wet.
- d. Application of impervious sheet material conforming to ASTM C 171.
- e. Application of membrane-forming curing compound conforming to ASTM C 309, Type 1-D, on surfaces permanently exposed to view and Type 2 on other surfaces shall be accomplished in accordance with manufacturer's instructions.

The preservation of moisture for concrete surfaces placed against wooden forms shall be accomplished by keeping the forms continuously wet for 7 days. If forms are removed prior to end of the required curing period, other curing methods shall be used for the balance of the curing period. During the period of protection removal, the

temperature of the air in contact with the concrete shall not be allowed to drop more than 25 degrees F within a 24 hour period.

### 3.6 TESTS AND INSPECTIONS

#### 3.6.1 General

The individuals who sample and test 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.

#### 3.6.2 Inspection Details and Frequency of Testing

##### 3.6.2.1 Preparations for Placing

Foundation or construction joints, forms, and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor to certify that it is ready to receive concrete.

### 3.6.2.2 Air Content

Air content shall be checked at least twice during each shift that concrete is placed for each class of concrete required. Samples shall be obtained in accordance with ASTM C 172 and tested in accordance with ASTM C 231.

### 3.6.2.3 Slump

Slump shall be checked twice during each shift that concrete is produced for each class of concrete required. Samples shall be obtained in accordance with ASTM C 172 and tested in accordance with ASTM C 143/C 143M.

### 3.6.2.4 Consolidation and Protection

The Contractor shall ensure that the concrete is properly consolidated, finished, protected, and cured.

### 3.6.3 Action Required

#### 3.6.3.1 Placing

The placing foreman shall not permit placing to begin until he has verified that an adequate number of acceptable vibrators, which are in working order and have competent operators, are available. Placing shall not be continued if any pile is inadequately consolidated.

#### 3.6.3.2 Air Content

Whenever a test result is outside the specification limits, the concrete shall not be delivered to the forms and an adjustment shall be made to the dosage of the air-entrainment admixture.

#### 3.6.3.3 Slump

Whenever a test result is outside the specification limits, the concrete shall not be delivered to the forms and an adjustment should be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the water-cement ratio does not exceed that specified in the submitted concrete mixture proportion.

### 3.6.4 Reports

The results of all tests and inspections conducted at the project site shall be reported informally at the end of each shift and in writing weekly and shall be delivered within 3 days after the end of each weekly reporting period. See Section 01451A CONTRACTOR QUALITY CONTROL.

-- End of Section --

DIVISION 4 - MASONRY

THRU

DIVISION 9 - FINISHES

NOT APPLICABLE

DIVISION 10 - SPECIALTIES

10430 Exterior Signage

## SECTION 10430

## EXTERIOR SIGNAGE

11/03

## 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.

## ALUMINUM ASSOCIATION (AA)

AA DAF-45 (2003) Designation System for Aluminum  
Finishes

## ASTM INTERNATIONAL (ASTM)

ASTM B 221 (2002) Aluminum and Aluminum-Alloy Extruded  
Bars, Rods, Wire, Profiles, and tubes

NATIONAL ASSOCIATION OF ARCHITECTURAL  
METAL MANUFACTURERS (NAAMM)

NAAMM MFM (1988) Metal Finishes Manual

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. 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

Modular Exterior Signage System

Manufacturer's descriptive data and catalog cuts.

Installation

Manufacturer's installation instructions and cleaning instructions.

Exterior Signage; G

Exterior signage schedule in electronic media with spread sheet format. Spread sheet shall include sign location, sign type, and message.

#### SD-10 Operation and Maintenance Data

##### Protection and Cleaning

Six copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. The instructions shall include simplified diagrams for the equipment as installed.

#### 1.3 GENERAL

All exterior signage shall be provided by a single manufacturer. Exterior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation. Recyclable materials shall conform to EPA requirements in accordance with Section 01670 RECYCLED / RECOVERED MATERIALS.

#### 1.4 WIND LOAD REQUIREMENTS

Exterior signage shall be designed to withstand 100mph windload.

#### 1.5 CHARACTER PROPORTIONS AND HEIGHTS

Character proportions and heights will be as indicated on drawings.d

#### 1.6 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

## 1.7 DELIVERY AND STORAGE

Materials shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

## 1.8 WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

## 1.9 EXTRA STOCK

The Contractor shall provide three [3]extra interchangeable message panels and extra stock of the following: Two[2] USAF Type 2 Controlled Area Warning signs and One [1] FAA L-585 Flightline Area sign.

## PART 2 PRODUCTS

### 2.1 MODULAR EXTERIOR SIGNAGE SYSTEM

Exterior signage shall consist of a system of coordinated directional, identification, and regulatory type signs located where shown. Dimensions, details, materials, message content, and design of signage shall be as shown on the drawings.

#### 2.1.1.1 Framing

Interior framing shall consist of aluminum tube columns welded to companion plates. Perimeter framing shall consist of aluminum and shall be bolted to the post and plate system as designed. Framing members shall be designed to permit panel removal. Mounting shall be provided as Shown on the drawings. Openings shall be sealed from moisture and made tamper-proof.

#### 2.1.1.2 Exterior Sheeting Panels

Modular panels shall be provided in sizes shown on drawings.

#### 2.1.1.3 Mounting

Mounting shall be provided by securing to concrete foundation as shown on drawings.

#### 2.1.1.4 Finishes

Base finish shall remain as delivered by the manufacturer.

### 2.1.2 Posts

One-piece aluminum posts shall be provided with minimum 0.125 inch wall thickness. Posts shall be designed to accept panel framing system described. Caps shall be provided for each post.

#### 2.1.2.1 Panels

Modular message panels shall be provided in sizes shown on drawings. Panels shall be fabricated a minimum of 0.080 inch aluminum components.

#### 2.1.2.2 Finishes

Post finish shall be as delivered by the manufacturer.

#### 2.1.2.3 Mounting

Mounting shall be provided by attaching posts to concrete foundation using frangible couplings as specified in the drawings and per manufactures instruction. Breakaway couplings must not be more than 3 inches above top foundation.

### 2.2 GRAPHICS FOR EXTERIOR SIGNAGE SYSTEMS

#### 2.2.1 Graphics

Signage graphics shall conform to the following:

- a. As shown on drawings

#### 2.2.2 Messages

See drawings for message content. Typeface: Helvetica medium; Type size: As indicated on drawings.

### 2.3 ALUMINUM ALLOY PRODUCTS

Aluminum alloy products shall conform to ASTM B 209M ASTM B 209 for sheet or plate, ASTM B 221M ASTM B 221 for extrusions and ASTM B 26/B 26M or ASTM B 108 for castings. Aluminum extrusions shall be provided at least 1/8 inch thick and aluminum plate or sheet at least 16 gauge thick. Welding for aluminum products shall conform to AWS C1.1M/C1.1.

### 2.4 VINYL SHEETING FOR GRAPHICS

Vinyl sheeting shall be 5 to 7 year premium type and shall be in accordance with the flammability requirements of ASTM E 84 and shall be a minimum 0.003 inch film thickness. Film shall include a precoated pressure sensitive adhesive backing, Class 1, or positionable pressure sensitive adhesive backing, Class 3.

### 2.5 ANCHORS AND FASTENERS

Exposed anchor and fastener materials shall be compatible with metal to which applied and shall match in color and finish and shall be non-rusting, non-corroding, and non-staining. Exposed fasteners shall be tamper-proof.

### 2.6 SHOP FABRICATION AND MANUFACTURE

#### 2.6.1 Factory Workmanship

Work shall be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled shall be given a trial fit in the shop to ensure proper field assembly. Holes

for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Welding to or on structural steel shall be in accordance with AWS D1.1/D1.1M. Welding shall be continuous along the entire area of contact. Exposed welds shall be ground smooth. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practical. Items specified to be galvanized shall be by hot-dip process after fabrication if practical. Galvanization shall be in accordance with ASTM A 123/A 123M and ASTM A 653/A 653M, as applicable. Other metallic coatings of steel sheet shall be in accordance with ASTM A 924/A 924M. Joints exposed to the weather shall be formed to exclude water. Drainage and weep holes shall be included as required to prevent condensation buildup.

#### 2.6.2 Dissimilar Materials

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, or absorptive materials subject to wetting, the surfaces shall be protected with a coat zinc-molybdate primer to prevent galvanic or corrosive action.

#### 2.7 COLOR, FINISH, AND CONTRAST

Color shall be as indicated on the drawings. Color listed is not intended to limit the selection of equal colors from other manufacturers. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Signs, plaques, or dimensional letters shall be installed in accordance with approved manufacturer's instructions at locations shown on the approved detail drawings. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified in manufacturers instructions.

##### 3.1.1 Anchorage

Anchorage and fastener materials shall be in accordance with approved manufacturer's instructions for the indicated substrate.

##### 3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned in accordance with manufacturer's instructions. After signs are completed and inspected, the Contractor shall cover all project identification, directional, and other signs which may mislead the public. Covering shall be maintained until instructed to be removed by the Contracting Officer or until the facility is to be opened for business. Signs shall be cleaned, as required, at time of cover removal.

-- End of Section --

DIVISION 11 - EQUIPMENT  
THRU  
DIVISION 15 - MECHANICAL  
NOT APPLICABLE

DIVISION 16 - ELECTRICAL

16010 General Electrical  
16040 Field Test and Operational Check  
16110 Raceways  
16120 Wires and Cables  
16135 Electrical Boxes and fittings  
16170 Circuit and Motor Disconnects  
16190 Supporting Devices  
16195 Electrical Identification  
16426 Drawout Switchgear  
16452 Grounding  
16470 Panelboards  
16477 Fuses

## SECTION 16010

## GENERAL ELECTRICAL

## PART 1 - GENERAL

## 1.1 RESPONSIBILITIES

- A. The Bidding Requirements, Conditions of Contract, General Specifications and General Requirements, and this Division shall be binding on the Contractor and shall apply to all electrical work to be completed under this section.
- B. The Contractor shall be responsible for the work from the date of his contract until its acceptance by the Government, and must make good all damages sustained from whatever cause. He shall use proper care and diligence in bracing and securing all parts of the work and shall in all cases judge as to the amount of protection required.

## 1.2 ORDINANCES, LAWS AND CODES

- A. All work shall conform to the rules and regulations of the National Electrical Code, Local Code, "Occupational Safety and Health Act" and the Base Fire Marshall's Office. All certificates of approval shall be delivered to the Contracting Officer/ Contracting Officer's Representative (CO/COR) before final payment will be made.
- B. Should any change in the drawings and/or specifications be required to conform to the above mentioned laws and ordinances, the CO/COR shall be notified by the Bidder prior to the bid date, that the necessary changes may be completed. After the bid date, all work necessary to meet the requirements shall be at Contractor's expense, with no additional cost to the Government.
- C. The Contractor shall pay for all fees, permits, taxes, inspections, connections, etc., associated with the work under this contract. Any costs, charges, or connection fees which are required to obtain permanent and temporary electrical service to the project facility will be paid by the Contractor as part of this contract.
- D. All products used on this project shall comply with the "Buy American Act". In some cases the "North American Free Trade Agreement" (NAFTA) may supercede the Buy American Act, however, the contractor must obtain written approval for the exception from the CO/COR prior ordering the equipment. In summary, compliance with the "Buy American Act" means that products must be manufactured with; 1) at least 51% United States material content, 2) at last 51% United States labor content and 3) final assembly of the product must be within the United States.

## 1.3 DATA AND MEASUREMENT

- A. The data given herein and on the drawings is as exact as could be secured insofar as building construction and existing conditions are concerned. Extreme accuracy is not guaranteed. The drawings and specifications are intended for the assistance of the Contractor in

achieving the end result. Exact locations, measurements, distance, levels, etc., will be governed by conditions at the job site.

- B. The Contractor shall verify that the size of the equipment supplied by the selected manufacturers does not exceed the available mounting space.
- C. The CO/COR reserves the right to change location or size of conduits outlets, fixtures or other pieces of equipment as may be necessary to avoid conflicts. No extra compensation will be allowed for such changes unless additional cost to the Contractor is caused.
- D. It is strongly recommended that the bidders visit the project site that he/she may have knowledge of conditions at the job site and adapt their bids and work to such conditions.

#### 1.4 DRAWINGS AND SPECIFICATIONS

- A. Anything mentioned in this specification and not shown on the drawings, or vice versa, shall be of like effect, as shown or mentioned in both. In any case of discrepancy or differences in the figures, drawings or specifications, the Bidder shall promptly report such discrepancies to the CO/COR who shall make a decision in writing. Any adjustment by the Contractor without this decision shall be at the expense of the Contractor.

#### 1.5 QUALITY OF WORKMANSHIP

- A. The Contractor shall give his personal superintendence and direction to the work. He shall also keep a competent foreman or superintendent on the project.
- B. All equipment, controls and junction boxes shall be located for ready access, operation, repair or maintenance.
- C. Any additional drawings necessary for the prosecution of the work will be furnished by the CO/COR as promptly as possible. The Contractor shall request any additional instructions needed and shall do no work without drawings and instructions.
- D. Any discrepancies between the electrical, structural, and civil drawings shall be reported to the CO/COR prior to the Bid Date.

#### 1.6 GUARANTEE

- A. This Contractor shall guarantee all materials, workmanship and the successful operation of all apparatus furnished and installed by him for a period of one year from the date of the final acceptance of the whole work, and shall guarantee to repair or replace at his own expense any part of the apparatus which may show defect during that time, provided such defect is, in the opinion of the CO/COR, due to imperfect material or workmanship and not to carelessness or improper operation. Guarantee period for the replacement shall begin with the date of replacement.
- B. The Government shall notify the Contractor of any failure of any part or parts which occur during the guarantee period.

- C. The Contractor shall also guarantee the systems and the apparatus to be working properly to meet all conditions as specified.

#### 1.7 SHOP DRAWINGS

- A. Shop drawings, catalogue sheets and manufacturer's data shall be submitted in accordance with the requirements of Paragraph "Shop Drawings" of the General Conditions. On or before thirty days after award of contract, the Contractor shall submit six copies of all fabricated work and equipment to be purchased. Data shall be sufficiently completed to permit evaluation and comparison with specified equipment and material.
- B. All drawings shall bear the Contractor's stamp of approval and must be dated.
- C. Shop drawings and/or catalogue and data sheets shall include, but not be limited to the following:
  - 1. Contactors and Time Clocks
  - 2. Low Voltage Switching System
  - 3. Panelboards, Disconnect Devices, Transformers
  - 4. Hand Holes
  - 5. Wire and Cable
  - 6. Termination and Splice Equipment
  - 7. Boxes and Devices
  - 8. Fuses
  - 9. Lamps
- D. A notation shall be made on each item submitted as to its specified use or description of specific location in the work.
- E. None of the preceding items shall be purchased, delivered to the site or installed until the item has been properly submitted in writing and reviewed by the CO/COR.
- F. Submittals shall be made even though the item is exactly as specified.
- G. Should the Contractor fail to comply with any of the requirements as stated, the CO/COR reserves the right to select a full line of materials, appliances, and equipment which shall be final and binding upon the Contractor.

#### 1.8 SUBMITTAL DATA

- A. Review of submittal data is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for: Dimensions that shall be confirmed and correlated at the job site; fabrication processes and techniques of construction; coordination of his work with that of all other trades and the satisfactory performance of his work.
- B. Contractor will be limited to one review on a singular piece of equipment.

- C. The listing of a manufacturer as "acceptable" does not imply automatic compliance with contract documents. It is the sole responsibility of the Contractor to insure that any price quotations received and submittals made are for equipment/systems which meet or exceed the specifications included herein.

#### 1.9 EQUAL MANUFACTURERS/EQUIPMENT

- A. Any approval requests for manufacturer/equipment to be considered as equal other than as specified herein and on the drawings shall be submitted to the CO/COR not less than 10 days prior to bid date.
- B. Requests for review shall be sufficiently complete to permit evaluation and comparison with specified equipment and material.
- C. Requests for substitutions shall be accompanied by a written comparison between the specified item and the substituted item. Request submittals shall be accompanied by complete technical data, including laboratory reports, if applicable on the proposed product. Each item proposed for substitution shall be clearly identified. Explain fully the differences, if any, between the proposed product and the products named in the Specifications. Failure to provide the above information may result in the rejection of the submittal.
- D. Only one (1) request for substitution for each product will be considered. When substitution is not accepted, provide specified product.
- E. If at any time during the project it is determined that a product has been misrepresented as an equal to a specified product. The contractor shall be required to replace the product at his expense. This stipulation applies even if the engineer has provided his/her stamp of approval.

#### 1.10 SCHEDULE OF VALUES

- A. Schedule of values shall be submitted within 30 days after award of contract or as specified in Division 1 or General Conditions of contract.
- B. The schedule of values shall be broken down by individual specification section and shall delineate materials and labor. Specific cost break down information provided to the engineer will be held in confidence.

### PART 2 - PRODUCTS

#### 2.1 PROTECTION OF FIXTURES AND WARES

- A. This Contractor shall apply the necessary protective coverage to fixtures and other equipment to prevent scratches and mars to such equipment as a result of falling objects or work of other trades.

## 2.2 STORAGE

- A. This Contractor shall provide and be responsible for safe storage of his materials and such storage shall not interfere with the work of others or progress of the project in any manner.

## 2.3 EQUIPMENT ENCLOSURES

- A. Provide enclosures that mate properly with the equipment to be enclosed and are NEMA rated to suit the atmospheric conditions of the equipment surroundings.
- B. Equipment in corrosive atmosphere shall be rated NEMA 4X. All NEMA 4X equipment shall be fabricated from suitable non-metallic material or shall be stainless steel. Painted steel is not acceptable for NEMA 4X applications.

## PART 3 - EXECUTION

## 3.1 COORDINATION

- A. Before installing any work, this Contractor shall coordinate the electrical work with all other contractors on the project, with the CO/COR, Telecommunications and Power Groups and Airfield Management.
- B. All electrical work shall be installed in proper sequence and so arranged with other trades that there will be no delay in the proper installation and completion of any part or parts of all systems and equipment.
- C. This Contractor shall carefully examine the drawings and shall be responsible for the proper fitting of equipment and conduit as indicated without major alteration. If alterations are required, a detailed drawing of the proposed departure due to actual field conditions or other causes shall be submitted to the CO/COR for approval.
- D. Whenever interferences might occur, before installing any of the work in question, the Electrical Contractor shall consult with other contractors and shall come to an agreement with them as to the exact location and level of his conduit and/or parts of his installation.
- E. All changes in the work of this Contractor, caused by his neglect to follow these instructions, shall be made at this Contractor's expense.

## 3.2 DITCHING, EXCAVATION, AND BACKFILLING

- A. Contractor shall do all excavation required to install conduits and equipment shown on drawings or required for proper operation. Excess excavation below the required level shall be backfilled with earth and thoroughly tamped.

### 3.3 CONNECTIONS FOR EQUIPMENT

- A. Coordinate the hook up of the following equipment with the Contractor required to furnish and install them. See the appropriate sections in the General Construction Work specifications for further information.
  - 1. Signage
  - 2. Government Furnished Equipment
- B. Verify fuse or circuit breaker requirements for electrical connections to equipment and provide overcurrent devices accordingly.

### 3.4 WORK ON EXISTING AIRFIELD

- A. Inasmuch as work under this contract includes adding to the existing airfield, it shall be the responsibility of each bidder to fully inform himself of any and all conditions which influence or are influenced by work contemplated by these specifications and accompanying drawings. The submission of a proposal by any bidder will be construed as an admission by him that he has examined and is fully familiar with the premises and all conditions thereon and adjacent thereto, and has included in this proposal a proper and adequate amount to cover rearrangement of old work for the proper installation and operation of the new and existing equipment as shown on the drawings specified herein, or as required. Such work shall be neatly and properly done.
- B. Maintain existing electrical service and feeders to occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by CO/COR. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When that "cutting-over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.
- C. The operation of all special systems within the building shall be maintained, including but not limited to; fire alarm, telephone, intercom, data communications, security, emergency call, etc. Provide temporary connections and/or equipment as required to maintain operations during construction. Anticipated momentary outages in any system must be scheduled with the Government before starting work.

### 3.5 DEMOLITION AND REMOVAL OF EXISTING EQUIPMENT AND MATERIALS

- A. Existing conduits may, at the Contractor's option, be removed, or reused.
- B. Conduits may not be abandoned in place in unfinished and accessible areas. Conduits may be abandoned in place when concealed in walls, floors and/or above hard ceilings.
- C. All conduits to be reused shall be thoroughly tested and checked for continuity.
- D. Electrical items must be removed where they interfere with or are not concealed by new construction.

- E. Existing equipment and material shall be relocated, removed, reconnected or left in place as indicated on the drawings. Where an existing device is shown removed from an existing circuit, new wiring shall be provided as required to insure continuity of existing circuit.
- If existing devices or other electrical items, such as electrically operated equipment interfere with the location of a new partition, relocation of existing equipment, new equipment, etc., the existing items including electrical components of electrically operated equipment shall be disconnected and removed or satisfactorily relocated and reconnected even though not specifically indicated on the drawings.
- All material removed which is considered salvageable by the Government and is not specifically designated to be reused on the drawings or not practical to be reused shall remain in the property of the Government and shall be neatly stockpiled in a specially designated location.

### 3.6 TEMPORARY WIRING (Existing Electrical Service)

- A. This Contractor shall provide temporary power.
- B. Temporary power may be derived from the existing electrical service.
- C. All materials for the temporary service and wiring may be used and remains the property of the electrical contractor.
- D. Temporary wiring materials are not to be installed as part of the permanent wiring system.
- E. Wiring need not be installed in conduit, but must be adequately installed and protected from mechanical injury to prevent shock.
- F. Permanent wiring including feeders, panels, receptacles, etc., may be used as soon as installed.
- G. The Electrical Contractor shall bear all installation costs necessary to connect and disconnect the temporary service.

### 3.7 CLEANING

- A. This Contractor shall at all times keep the premises free of all waste or surplus materials, rubbish, and debris which is caused by his employees or resulting from his work.
- B. After all equipment and fixtures have been installed and building is ready for occupancy, the Electrical Contractor shall remove all stickers, rust stains, labels, temporary covers, plaster marks, paint spots, etc. All foreign matter shall be blown out or flushed out of all conduits, panels, motors, devices, switches, fixtures, etc.
- C. Identification plates and trims on all equipment shall be free of paint and polished.
- D. The Contractor shall leave the electrical portion of the work in a safe clean, and very neat condition ready for operation.

## 3.8 RECORD DRAWINGS

- A. The Contractor shall maintain an up-to-date set of plans and specifications on the job site. He shall annotate all field changes, addendums, change orders, etc. on this set. Once the job is complete, the contractor shall supply this set of drawings, updated in AutoCad (minimum V.2000) to the CO/COR for review.
- B. The drawings shall also include as-built conditions such as equipment and device locations, routing of service entrance and major feeders, branch circuit changes, final panelboard schedules, etc.

## 3.9 INSTRUCTION IN OPERATION BOOKS AND SPARE PARTS

- A. After all tests and adjustments have been made, the Contractor shall furnish the necessary qualified personnel to place the special systems in continuous operation, during which time he shall provide complete operating and maintenance instructions to the Government's representative with an outline of instructions in written form. These personnel shall reserve adequate time to instruct a Government's representative on proper operation (including all phases of the system and each of its component parts).
- B. Contractor shall furnish Government with three sets of all operating instructions, maintenance instruction and spare parts lists of all equipment furnished under this contract. Lists shall include current unit prices and source of supply for each item of operable equipment.

## 3.10 TESTS AND ADJUSTMENTS

- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.
- B. During the progress and after completion of the work included under this specification, the Contractor shall make all required tests at his own expense in the presence of the CO/COR as required hereinafter and by local ordinances, codes, laws, and regulations. Such tests shall be in accordance with other sections of this division. The CO/COR shall be notified five (5) days in advance as to the time when such tests are to be performed that a representative of the CO/COR may be present.

## 3.11 DISPOSAL OF HAZARDOUS ELECTRICAL MATERIALS - (BALLASTS AND LAMPS)

- A. The electrical contractor shall be responsible for the removal, storage and disposal of all electrical related hazardous material from the work site in an EPA approved manner.
- B. All hazardous material shall be stored in a safe and secure area pending disposal. All PCB ballasts shall be stored in metal 55 gallon drums with a bolt on lid securing ring, or in other locked metal containers. The enclosure shall be properly labeled per EPA guidelines while awaiting shipment to a disposal facility.

- C. Fluorescent lamps containing mercury or other hazardous materials shall be sent to an EPA approved Recycling Center. Disposal of lamps at a standard landfill shall not be permitted.
- D. PCB ballasts shall only be disposed of by incineration at an EPA registered PCB incineration facility. Disposal of ballasts at a standard landfill shall not be permitted.
- E. The contractor shall keep accurate records of all such hazardous materials and provide the engineer with properly completed Certificates of Disposal, issued by the receiving disposal facility. Certificates of disposal issued by a third party other than the final disposal facility it self will not be acceptable. Final project payment may be withheld pending the engineer's receipt of properly completed Certificates of Disposal.

END OF SECTION

## SECTION 16040

## FIELD TEST AND OPERATIONAL CHECK

## PART 1 - GENERAL

## 1.1 CONDITIONS AND REQUIREMENTS

- A. Refer to other Division 16 Specification for Supplemental

## 1.2 DESCRIPTION

- A. Work Included in this Section:
  - 1. Distribution Equipment
  - 2. Ground Resistance Test
  - 3. 600 Volt Cable Insulation Test
  - 4. Neutral Isolation Test

## 1.3 GENERAL SCOPE

- A. It is the intent of these tests to assure that all electrical equipment is operational within industry and manufacturer's tolerances and is installed in accordance with design specifications.
- B. The test and inspections shall determine the suitability for energization.

## 1.4 TEST REPORT

- A. The test report shall include the following:
  - 1. Summary of project
  - 2. Description of equipment tested
  - 3. Description of tests
  - 4. List of test equipment used and most recent calibration date
  - 5. Test results
  - 6. Conclusions and recommendations
  - 7. Appendix, including appropriate test forms
- B. The test report shall be bound and its contents certified.
- C. Submit 3 copies of the completed report to the CO/COR no later than 15 days after completion of test unless directed otherwise.

## 1.5 FAILURE TO MEET TEST

- A. Any system material or workmanship which is found defective on the basis of acceptance test shall be reported directly to the CO/COR.
- B. Contractor shall replace the defective material or equipment and have test repeated until test proves satisfactory, without additional cost to Government.

## PART 2 - PRODUCTS (NOT APPLICABLE)

## PART 3 - EXECUTION

## 3.1 GROUND RESISTANCE TEST

- A. Building grounding electrode resistance testing shall be accomplished with a ground resistance direct-reading single test meter utilizing the AD Fall-of Potential Method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the ground electrode to be tested and the two reference electrodes in a straight line spaced 50 feet apart. Drive the two reference electrodes 5 feet deep
- B. Test results shall be in writing and shall show temperature, humidity, and condition of the soil at the time of the tests.

## 3.2 600 VOLT CABLE INSULATION TEST

- A. Megger and record insulation resistances of all 600 volt insulated conductors size 4/0 AWG and larger using a 500 volt megger for one minute. Make tests with circuits isolated from source and load.

## 3.3 DISTRIBUTION EQUIPMENT

- A. Check cleanliness of all interiors and all parts. Remove any excess packing, shipping bolts, etc.
- B. Tighten all points of connection with torque wrench. Torque values per manufacturer's recommendation.
- C. Verify all proper operating condition of equipment mechanically and electrically.
- D. If any equipment is found defective during operational check, it shall be replaced by the Contractor without cost to the Government and test repeated by the Contractor without cost to the Government and test repeated until satisfactory results are obtained.

## 3.4 NEUTRAL ISOLATION TEST

- A. Disconnect neutral from system ground and megger resistance between system neutral and ground to ensure that no neutral conductors are grounded throughout the system. Isolate and correct any improper grounds, and record resistance to ground for each system.

END OF SECTION

## SECTION 16110

## RACEWAYS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. All wiring shall be installed in continuous raceways as specified herein except where specifically noted otherwise.
- B. Types of raceways in this section include the following:
  - 1. Electrical metallic tubing.
  - 2. Flexible metal conduit.
  - 3. Liquid-tight flexible metal conduit.
  - 4. Rigid metal conduit.
  - 5. Rigid nonmetallic conduit.

## PART 2 - PRODUCTS

## 2.1 METAL CONDUIT AND TUBING

- A. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated, provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways.
- B. Rigid Steel Conduit: Provide rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1 and UL 6. Provide zinc coating fused to inside and outside walls.
  - 1. Rigid Metal Conduit Fittings: Rigid metal conduits shall have threaded couplings when installed in concrete or direct burial in the ground. Other installations in dry locations may be threadless rigid fittings.
  - 2. PVC Externally Coated Rigid Steel Conduit: Provide rigid steel zinc-coated with additional external coating of PVC conforming to ANSI C80.1 and NEMA RN 1.
- C. Flexible Metal Conduit: Provide flexible metal conduit conforming to FS WW-C-566 and UL 1. Formed from continuous length of spirally wound, interlocked zinc-coated strip steel.
  - 1. Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.
    - a. Straight Terminal Connectors: One piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.
    - b. 45° or 90° Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

- D. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC).
1. Liquid-Tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat.
- E. Electrical Metallic Tubing (EMT): Provide electrical metallic tubing conforming to FS WW-C-563, ANSI C80.3 and UL 797.
1. EMT Fittings: Fittings for EMT shall be steel and may be of the screw or compression type except that in poured concrete the screw type is not acceptable. All EMT connectors shall be of the insulated throat type. Cast or indenter fittings are not acceptable.
- F. Conduit Bodies: Provide galvanized cast-metal conduit bodies of types, shapes and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded-conduit-entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.
- 2.2 NONMETALLIC CONDUIT:
- A. General: Provide nonmetallic conduit and fittings of types, sizes and weights as specified.
- B. Rigid Nonmetallic Conduit:
1. Heavy Wall Conduit: Schedule 40, 9- c, UL-rated, construct of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, or normal above ground use, UL-listed and in conformity with NEC Article 347.
  2. Extra Heavy Wall Conduit: Schedule 80, UL-rated, construct of polyvinyl chloride compound C-200 PVC, and UL-listed in accordance with NEC Article 347 for direct burial, or above ground use.
- C. Conduit, and Tubing Accessories: Provide conduit and tubing duct accessories of types, sizes, and materials, complying with manufacturer's published product information, which mate and match conduit and tubing.
- 2.3 WIREWAYS
- A. General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service as indicated. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as required for complete system.
- B. Lay-in Wireways: Lay-in wireways with hinged covers, in accordance with UL 870 and with components UL-listed, including lengths, connectors, and fittings. Select units to allow fastening hinged cover closed

without use of parts other than standard lengths, fittings and connectors. Construct units to be capable of sealing cover in closed position with sealing wire. Provide wireways with knockouts.

1. Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached that removal is not necessary to utilize the lay-in feature.
2. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF RACEWAYS

- A. General: Install raceways as indicated; in accordance with manufacturer's written installation instructions, and in compliance with NEC, and NECA's "Standards of Installation". Install units plumb and level, and maintain manufacturer's recommended clearances.
- B. Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceways and components with other work.

#### 3.2 INSTALLATION OF CONDUITS

- A. General: All conduits shall be concealed unless noted otherwise. Install concealed conduits either in walls, slabs, or above hung ceilings. In existing work where conduits can not be concealed in finished areas, surface metal raceways shall be used, but prior approval is required.
  1. Mechanically fasten together metal conduits, enclosures, and raceways for conductors to form continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.
  2. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
  3. Install miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install expansion fittings in raceways every 200' linear run or wherever structural expansion joints are crossed.
  4. Use roughing-in dimensions of electrically operated unit furnished by supplier. Set conduit and boxes for connection to units only after receiving review of dimensions and after checking location with other trades.
- B. Conduit Installation: Provide rigid conduit where embedded in concrete on or below grade, in direct contact with earth or fill below slab, wet locations, or installed outdoors. Follow minimum requirements in other areas as follows:

1. Where acceptable to all authorities having jurisdiction, intermediate metal conduit may be used in lieu of rigid steel conduit in non-hazardous locations when in compliance with NEC.
  2. Use PVC coated rigid steel conduit and fittings where installed in corrosive atmosphere. Patch all nicks and scrapes in PVC coating after installing conduit.
  3. Use steel zinc-coated EMT for raceway systems except as specifically specified previously, where not allowed by NEC or noted on drawings. Additionally EMT shall not be acceptable below grade, in or under slabs on grade or in wet locations.
  4. Use liquid-tight flexible conduit in movable partitions and in systems furniture connections. Use flexible metal conduit from outlet boxes to recessed lighting fixtures above accessible ceilings. Use liquid-tight flexible metal conduit for the final 24" of connection to motors, or control items subject to movement or vibration.
  5. Use liquid-tight flexible conduit where subjected to one or more of the following conditions:
    - a. Exterior location.
    - b. Moist or humid atmosphere where condensate can be expected to accumulate.
    - c. Pump motors.
    - d. Corrosive atmosphere.
    - e. Subjected to water spray or dripping oil, water or grease.
  6. Rigid Non-Metallic Conduits:
    - a. Rigid non-metallic conduits may be used below grade or embedded in concrete on or below grade only.
    - b. Rigid non-metallic conduits shall not be used for stub-ups above floor.
    - c. Make solvent cemented joints in accordance with recommendations of manufacturer.
    - d. Install rigid non-metallic conduits in compliance with NEC, local utility practices, and all other authorities having jurisdiction.
- C. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling thread inside the plugs and set flush with the finished pad. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.
- D. Protect stub-ups from damage where conduits rise from slabs. Arrange so curved portion of bends is not visible above the finished slab.
- E. Install pull wires in empty raceways. Use no. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.
- F. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean. Use temporary closures to prevent foreign matter from entering raceways.

- G. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
- H. Size conduits to meet NEC requirements and as shown on drawings or specified herein, except no conduit smaller than 3/4 inch shall be embedded in or below concrete or in masonry walls.
- I. Fasten rigid conduit terminations in sheet metal enclosures with locknuts inside and outside enclosure or with threadless rigid box connectors and terminate with bushing.
- J. Conduit terminations in wet locations shall be of the threaded hub type or other sealing type fittings UL listed for use in wet locations.
- K. Conduit shall be properly supported as specified herein and as required by NEC.
- L. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.
- M. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
- N. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
  - 1. Where conduits enter or leave hazardous locations.
  - 2. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
  - 3. Where required by the NEC.
- O. Conduit Fittings:
  - 1. Construct locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.
  - 2. Plastic insulating bushings for terminating rigid conduits smaller than 1-1/4" are to have ribbed sides, with smooth upper edges to prevent injury to cable insulation.
  - 3. Install metallic insulated type bushings for terminating rigid conduits 1-1/4" and larger. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.
  - 4. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs to be specifically designed for their particular application.

END OF SECTION



## SECTION 16120

## WIRES AND CABLES

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Extent of electrical wire and cable work is indicated by drawings and schedules.
- B. Types of electrical wire, cable, and connectors specified in this section include the following:
  - 1. Copper conductors.
  - 2. Tap type connectors.
  - 3. Compression type connectors.
  - 4. Wirenut connectors.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements of this specification.

## 2.2 WIRES, CABLES, AND CONNECTORS

- A. General: All reference to size in these specifications or on drawings is for copper conductors. Provide electrical wires, cables, and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, for a complete installation, and for application indicated. Except as otherwise indicated, provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
- B. Aluminum conductors may not be provided in lieu of copper conductors.
- C. Building Wires: Provide factory-fabricated wires of sizes, ampacity ratings, and materials for applications and services indicated. Where not indicated, provide proper wire selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards.
- D. Cables: Provide UL-type factory-fabricated cables of sizes, ampacity ratings, and materials and jacketing/sheathing as indicated for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements, NEC and NEMA standards.
- E. Medium Voltage Cables: Medium voltage cables shall conform to the requirements of NEMA WC 7 for cables utilizing cross-linked thermosetting polyethylene (XLP) insulation. Cables shall be in accordance with the requirements of NFPA 70. If metallic armored

cables are specified, then they shall be three-conductor, multiple-conductor cable with interlocked-metal tape armor and thermoplastic jackets as required for the specific application either underground or in conduit.

1. Insulation: Cables shall utilize cross-linked thermosetting polyethylene (XLP) insulation. Cables shall be provided with 133 percent insulation level except that 28 kV and 35 kV rated cable insulation thicknesses shall be in accordance with AEIC CS5.
2. Jackets: Cables shall be provided with a nonmetallic jacket. Concentric neutral cables for direct buried applications shall have a moisture-resistant, nonmetallic jacket rated for direct burial.
3. Neutrals: Neutral conductors of grounded neutral systems except for concentric neutral cables shall be of the same insulation material as phase conductors, except that a 600-volt insulation rating is acceptable. Cables employing a concentric neutral shall have full concentric neutral with an insulating jacket over the concentric neutral.
4. Shielding: Cables rated for above 2 kV shall have both conductor and insulation shielding for each phase, except insulation shielding is not required for 5 kV armored or metallic-sheathed cable.

### 2.3 CONNECTORS (600V AND BELOW)

- A. General: Provide UL-type factory-fabricated, metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements, NEC and NEMA standards.
- B. Compression type connectors: Compression connections shall be the type requiring hydraulic compression tools operating at a minimum pressure of 7000psi with an output pressure of no less than 10 tons.
- C. Splice Enclosures (Low Voltage):
  1. Splice enclosures shall meet Bell System standards for pressure tight splice enclosures. Size shall be determined by the number of conductors to be enclosed.
  2. Enclosure shall be re-enterable with end seal fittings and filled encapsulant suitable to the environment.
- D. Splice Connectors "Clear Caps" (Low Voltage):
  1. Splice connectors shall be suitable for terminating/splicing telephone cable conductors (#26-#19 AWG) in size).
  2. The connector shall be provided with encapsulant in place in the connector.
  3. The connectors shall have a clear polycarbonate housing with a limiting oxygen index of 35.

### 2.4 CONNECTORS (5KV TO 15KV)

- A. 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. Joints shall have ratings not less than the ratings of the cables on which they are installed. Splice kits for up to 15KV may be of the heat-shrinkable type or the premolded splice and connector type. Joints used in manholes, handholes, vaults and pull boxes shall be certified by the manufacturer for waterproof, submersible applications.

- B. Medium-Voltage Separable Insulated Connectors: Separable insulated connectors shall comply with IEEE Std 386 and IEEE Std 592 and shall be of suitable construction. Separable insulated connectors are acceptable for voltages up to 15 kV. Connectors shall be of the loadbreak type as indicated and shall be of suitable construction for the application and the type of cable connected. Connectors 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.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF WIRES AND CABLES OTHER THAN MEDIUM VOLTAGE

- A. General: Install electrical cables, wires and wiring connectors as indicated, in compliance with applicable requirements of NEC, NEMA, UL, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. The normal minimum size shall be 12 AWG. All wire No. 10 and smaller to be solid, all No. 8 and larger shall be stranded.
- C. All service entrance feeders shall be type USE or type RHW. All other feeder and branch circuit wiring shall be type THHN/THWN.
- D. Pull conductors simultaneously where more than one is being installed in same raceway.
- E. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation. Use of soap will not be permitted as pulling lubricant.
- F. Insulation on conductors shall be permanently marked with wire size, insulation type, voltage range and manufacturer's name. The insulation on conductors shall be color coded as follows:
  - 1. 120/240 volt circuit: Phase A - Black; Phase B - Red; Neutral - White; Ground - Green.
  - 2. 277/480 volt circuit: Phase A - Brown; Phase B - Orange; Phase C - Yellow; Neutral - White w/stripe (not green); Ground - Green w/stripe.
- G. The phase conductors shall be tagged and shall remain the same throughout the circuit.
- H. Switch legs shall be color coded to distinguish them from Hot or Phase Conductors.
- I. Switch legs occurring in the same box or enclosure shall be color coded separately.

- J. Exceptions to the color coding as listed above shall be as follows:
1. Wiring for special systems shall be color coded or labeled as required by the manufacturer.
- K. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway.
- L. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible. Prior approval is required for all exposed cabling.
- M. Keep conductor splices to minimum.
- N. Install splices and taps which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.
- O. Use splice and tap connectors which are compatible with conductor material.
- P. All splices and taps shall be made in outlet, junction and pull boxes. Splices on circuit wiring shall be of the pigtail type using solderless connectors. Larger sizes of conductors requiring un-insulated connectors of the bolt type shall be taped with pressure sensitive vinyl tape.
- Q. For branch circuit wiring, conductor fill per conduit run shall not contain more than 6 current carrying wires. Conduits containing both circuit switch legs and/or traveler wires may contain more than the number stated above, providing the conduit is of adequate size and the wire size is derated as required by the National Electrical Code. Whenever a 120V, single phase branch circuit is over 70 feet in length, or a 277V, single phase branch circuit is over 150 feet, and the load is in excess of 50 percent of the branch circuit protective device, the conductors shall be increased one size to the first outlet box unless specifically noted otherwise. For special systems conductor fill of conduit is per manufacturer's specifications furnished with each system, noted on the drawings or shall be as required by code.
- R. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A and B.
- S. On occasion the contractor must route branch circuits in a non-direct path to the equipment/device to avoid unforeseen obstacles. The contractor shall evaluate and upgrade these branch circuits (either low voltage or 600v) as needed to minimize voltage drop. The maximum allowable voltage drop for branch circuits is 5%.
- 3.2 MEDIUM VOLTAGE CABLES (5kv - 35kv)
- A. Cable joints or splices in direct-burial cables are not permitted in runs of 1000 feet or less, nor at intervals of less than 1000 feet in longer runs, except as required for taps. Locations of cable joints or splices in shorter intervals, where required to avoid obstructions or damage to cables, must have prior approval. Cable joints or splices in

direct burial installations shall be installed in above-ground junction boxes or in cast metal splice boxes suitable for direct burial use. Cable joints or splices in duct banks shall be made only in manholes, handholes, or pullboxes.

- B. Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in writing. 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.
- C. Fire-stops shall be installed in each conduit entering or leaving a manhole.

### 3.3 FIELD QUALITY CONTROL

- A. Prior to energization of circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.
- C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

### 3.4 ABANDONED WIRING

- A. All existing wiring and cabling left unused as a result of this project shall be removed and disposed of. In the case of cabling all associated fastening systems such as wire staples, tie-wraps, electrical tape, etc. shall also be removed. All wiring/conductors in unused conveyances shall be removed. The conveyances may or may not require removal. Refer to the drawings and other specification sections for direction regarding unused conveyances.
- B. On rare occasions, where noted specifically on the drawings wiring may be abandoned in place. However, the wire/cable must be tagged or otherwise identified at all of its termination and junction points as "Abandoned in Place". The individual conductors must be insulated from contact with other conductors and/or electrical equipment/devices.

END OF SECTION



## SECTION 16135

## ELECTRICAL BOXES AND FITTINGS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. The extent of electrical box and associated fitting work is indicated by drawings and schedules and shall comply with the latest requirements of the NEC.
- B. Types of electrical boxes and fittings in this section include the following:
  - 1. Outlet boxes.
  - 2. Junction boxes.
  - 3. Pull boxes.
  - 4. Bushings.
  - 5. Lock nuts.
  - 6. Knockout closures.

## PART 2 - PRODUCTS

## 2.1 FABRICATED MATERIALS

- A. Outlet Boxes: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application.
  - 1. Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.
- B. Rain-tight Outlet Boxes: Provide corrosion-resistant cast-metal rain-tight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.
- C. Junction and Pull Boxes: Provide galvanized code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with steel nuts, bolts, screws and washers.
- D. Hand Holes:
  - 1. Hand holes shall be provided in the sizes indicated on the drawings. They shall be open bottom, stackable and shall have bolted covers with logos permanently imbedded into the cover.

2. Bolts and inserts shall be stainless steel. Covers shall be rated for 5000 lbs. over 10" square, rated for occasional non-deliberate light vehicular traffic.
  3. Hand hole and cover shall be resistant to sunlight exposure, weathering and chemicals. The hand hole shall be unaffected by freeze/thaw cycles.
- E. Bushings, Knockout Closures and Lock nuts: Provide corrosion-resistant box knockout closures, conduit lock nuts and conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. General: Install electrical boxes and fittings as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.
- B. Surface mounted boxes in exterior areas, shall be cast metal, threaded hub similar to Bell boxes.
- C. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- D. Provide weather-tight outlets for interior and exterior locations exposed to weather or moisture.
- E. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- F. Install electrical boxes in those locations that insure ready accessibility to enclosed electrical wiring. Junction boxes shall not be installed above non-accessible ceilings.
- G. Do not install aluminum products in concrete.
- H. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.
- I. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. Box support shall be independent of conduit.
- J. Provide electrical connections for installed boxes.
- K. Subsequent to installation of boxes, protect boxes from construction debris and damage.

3.2 GROUNDING

- A. Upon completion of installation work, ground electrical boxes as required by NEC and other Division-16 sections.

END OF SECTION

## SECTION 16170

## CIRCUIT AND MOTOR DISCONNECTS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Extent of circuit and motor disconnect switch work is indicated on drawings and schedules.
- B. Types of circuit and motor disconnect switches in this section include the following
  - 1. Equipment disconnects.
  - 2. Appliance disconnects.
  - 3. Motor-circuit disconnects.
- C. Wires/cables, raceways, and electrical boxes and fittings required in connection with circuit and motor disconnect work are specified in other Division-16 sections.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements of this specification.

## 2.2 DISCONNECT SWITCHES

- A. General-Duty Disconnect Switches: For switches rated less than 100 amps provide surface-mounted, general-duty type, sheet-steel enclosed switches, of types, sizes, and electrical characteristics indicated; rated for system voltage, 60 Hz, with required number of poles and solid neutral incorporating spring assisted, quick-make, quick-break switches. Equip with operating handle which is integral part of enclosure base and whose operating position is easily recognizable, and is capable of being padlocked in OFF position. Construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts and positive pressure type reinforced fuse clips where fusing is required. The enclosure shall be NEMA rated to suit the atmospheric conditions of the equipment surroundings and of the manufacturer's standard finish. When used as service disconnect, provide with UL markings indicating "suitable for use as service equipment".
- B. Heavy-Duty Disconnect Switches: For switches rated 100 amps or greater provide surface-mounted, heavy-duty type, sheet-steel enclosed switches, of types, sizes and electrical characteristics indicated; rated for system voltage 60 Hz, with required number of poles and solid neutral incorporating quick-make, quick-break type switches. Equip

with operating handle which is integral part of enclosure base and whose position is easily recognizable, and is padlockable in OFF position; construct current carrying parts of high-conductivity copper, with silver-tungsten type switch contacts, and positive pressure type reinforced fuse clips where fusing is required. The enclosure shall be NEMA rated to suit the atmospheric conditions of the equipment surroundings and of the manufacturer's standard finish. When used as service disconnect, provide with UL markings indicating "suitable for use as service equipment".

- C. Motor-Circuit Disconnect Switches Must Be HP Rated.
- D. Fuses: Provide fuses for disconnect switches, as recommended by switch manufacturer, of classes, types, and ratings needed to fulfill electrical requirements for service indicated.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES

- A. Install circuit and motor disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate motor and circuit disconnect switch installation work with electrical raceway work, location of equipment, and as necessary for proper interface. Provide U-channel supports from floor and/or structure where required to mount disconnects at free-standing equipment.

#### 3.2 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground as required by NEC and in "Grounding" section of Division-16.

#### 3.3 FIELD QUALITY CONTROL

- A. Subsequent to completion of installation of electrical disconnect switches, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at project site, then retest to demonstrate compliance; otherwise remove and replace with new units and retest.

END OF SECTION

## SECTION 16190

## SUPPORTING DEVICES

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
  - 1. Refer to other Division 16 sections for additional specific support requirements that may be applicable to specific items.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements of this specification.

## 2.2 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

## 2.3 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
  - 1. Expansion Anchors: Lead, carbon steel wedge or sleeve type. Plastic expansion anchors (for conduit 1" and smaller only).
  - 2. Toggle Bolts: All steel springhead type.
  - 3. Power-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with

steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 16-gage steel channels, with 9/16 inch diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match the U-channel and are of the same manufacture.

#### 2.4 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
  - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
    - a. 3-inch and smaller: 20-gage.
    - b. 4-inch to 6-inch: 16-gage.
    - c. Over 6-inch: 14-gage.
  - 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
  - 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with the NEC and the following requirements:
  - 1. Conform to manufacturer's recommendations for selection and installation of supports.
  - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200

- lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceways hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
- D. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- E. Support sheet metal boxes directly from the building structure or by bar hangers.
- F. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.
- G. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- H. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
  2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
  3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

END OF SECTION



## SECTION 16195

## ELECTRICAL IDENTIFICATION

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Extent of electrical identification is indicated by drawings and schedules.
- B. Types of electrical identification specified in this section include the following:
  - 1. Buried cable warnings.
  - 2. Electrical power, control and communication conductors.
  - 3. Operational instructions and warnings.
  - 4. Danger signs.
  - 5. Equipment/system identification signs.

## PART 2 - PRODUCTS

## 2.1 ELECTRICAL IDENTIFICATION MATERIALS

- A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.
- B. Plasticized Tags:
  - 1. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary working, e.g., DANGER, CAUTION, DO NOT OPERATE.
- C. Self-Adhesive Plastic Signs:
  - 1. General: Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.
    - a. Colors: Unless otherwise indicated or required by governing regulations, provide orange signs with black lettering.
- D. Baked Enamel Danger Signs:
  - 1. General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size

which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH).

E. Engraved Plastic-Laminate Signs:

1. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
  - a. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.
  - b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

F. Underground-Type Plastic Line Marker:

1. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape with metallic tracing wire/tape not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service or buried cable.

2.2 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.
2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Operational Identification and Warnings:

1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and

electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

C. Danger Signs:

1. General: In addition to installation of danger signs required by Governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about project.
  - a. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 250 volts.
  - b. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property where instructed by CO/COR.

D. Equipment/System Identification:

1. General: Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Signs for disconnect switches, motor starters, contactors, and similar equipment shall indicate the load served. Except as otherwise indicated, provide single line of text, 3/4" high lettering on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Lettering for emergency power system components shall be white lettering in red field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work.
  - a. Panelboards, electrical cabinets and enclosures.
  - b. Disconnect switches.
  - c. Contactors.
  - d. Transformers.
  - e. Telephone equipment.
  - f. Pull boxes and enclosures larger than 6" x 6".
2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

E. Underground Cable and Conveyance Identification:

1. General: During the installation of buried electrical cable and/or conveyances (power and signal), install continuous underground-type plastic line marker with tracing wire/tape, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
  2. Install line marker for every buried cable, regardless of whether direct buried or protected in conduit.
- F. Cable/Conductor Identification:
1. General: Apply cable/conductor identification in each box/enclosure/cabinet, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project electrical work.

END OF SECTION

## SECTION 16426

## DRAWOUT SWITCHGEAR

## PART 1 - GENERAL

## 1.1 WORK INCLUDED

- A. Extent of drawout switchgear work is indicated by drawings and as specified herein.

## 1.2 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of drawout switchgear of types, sizes and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects utilizing drawout switchgear similar to that required for this project.

## 1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on drawout switchgear including but not limited to voltages, number of phases, frequency, and short-circuit and continuous current ratings. Provide application data for main and feeder breakers, sections, main buses, and insulation levels.
- B. Shop Drawings: Submit layout drawings of drawout switchgear showing accurately scaled basic equipment sections including auxiliary compartments, section components, PC control system components, and combination sections.
- C. Wiring Diagrams: Submit wiring diagrams for drawout switchgear showing connections to electrical power feeders and distribution branches. Clearly differentiate between portions of wiring that are manufacturer-installed and portions to be field-installed.
- D. Maintenance Stock, Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units of each.
- E. Coordination Curves and Trip Settings: Submit device trip settings and coordination curves indicating proper coordination with existing and new system components.

## 1.4 REQUIREMENTS

- A. The drawout switchgear shall be UL listed and labeled as service entrance equipment. It shall be listed and labeled per UL and shall meet all the requirements of the local service provider where applicable.

- B. The drawout switchgear shall consist of: 1 - main utility circuit breaker section with controls, monitoring equipment, and feeder breaker sections.
- C. Coordinate the requirements of this installation with local service provider. Provide all engineering, testing, and certifications necessary to gain the approval of the utility company.
- D. Provide all equipment, materials, supplies, labor, engineering, testing, etc., necessary to furnish and install a complete and operating system.

#### 1.5 COORDINATION WITH LOCAL SERVICE PROVIDER

- A. The manufacturer of the equipment shall coordinate all requirements of this installation with local service provider. The manufacturer shall provide all engineering, coordination studies for relay settings, testing, certifications, etc., necessary to gain the approval of the utility company.
- B. Provide six copies of all submittal information to the Engineer for approval.
- C. Do not perform any work or order any equipment or material until approved submittal data has been received from the Architect/Engineer.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: These specifications are written for Power-Zone III type switchgear manufactured by the Square-D Company. Subject to compliance with these specifications, the following alternative manufacturers are approved:
  - 1. Cutler-Hammer Products
  - 2. General Electric Co.
  - 3. Siemens-Allis, ITE.
- B. Alternative manufacturers other than listed above are acceptable only if approved in writing by the Architect/Engineer and are subject to these specifications and the specifications of Square-D Company.

#### 2.2 OPERATING CONDITIONS

- A. The equipment will be installed indoors and shall be suitable for the following conditions:
  - 1. Humidity: 5% relative humidity (winter)  
95% relative humidity (summer, non-condensing)
  - 2. Elevation: 5000 feet above sea level
  - 3. Atmosphere: Clean air
  - 4. Temperature: Maximum +120°F.  
Minimum +20°F.

## 2.3 EQUIPMENT SECTIONS AND COMPONENTS

- A. General: Except as otherwise indicated, provide drawout switchgear and ancillary components of types, sizes, characteristics, and ratings indicated, which generally comply with Square-D's standard design, materials, components, and construction in accordance with published product information, and as required for complete installation.
- B. These specifications and associated drawings describe the indoor low voltage metal-enclosed drawout switchgear assembly. The assembly is to be designed for use on a [480] volt, three (3) phase, 4 wire (60) Hz. system, with [65,000] amperes symmetrical fault current available. Equipment is to be complete from the incoming line connections to the outgoing feeder connections. Any items not specifically mentioned but obviously necessary for proper operation are implied in this description.
- C. The low voltage section shall be designed, manufactured and tested in accordance with applicable NEMA, ANSI and IEEE standards for power circuit breakers and metal enclosed switchgear.
1. APPLICABLE STANDARD-STRUCTURES: NEMA SG5, ANSI C37.20, ANSI C37.51
- D. Enclosure:
1. The enclosure shall be finished with medium gray ANSI standard enamel applied over a rust inhibiting phosphate primer. Equipment shall be equipped with Service Entrance Label and UL 1558 label for metal-enclosed low voltage power circuit breaker type switchgear assemblies.
  2. The enclosure and internal barriers shall be fabricated of steel members in accordance with NEMA and ANSI standards. Steel lifting straps are to be provided with each shipping group to lift the structure from top with a crane. Supply a wooden skid to permit the use of pipe rollers for moving the switchgear to its final location in the building.
  3. All vertical sections shall be bolted together. Ventilation openings on the switchgear breaker compartments are to be located in such a way as to preclude the possibility of metal objects beings inserted through them and easily contacting energized parts. To barrier operator from escaping gases during an interruption, breakers shall be supplied with a steel front plate when ventilation openings are on the front of the breaker compartment.
  4. The assembly shall be adjusted and tested at the factory including the components of the Automatic Control System.
  5. Where overall dimensions are indicated on the drawings, the assembly must not exceed those dimensions without written approval from the Architect/Engineer. The controller shall verify that the equipment proposed will fit into the space provided.
  6. The structure is to consist of three basic compartments from front to rear: the front breaker compartment, the center bus compartment, and the rear cable compartment.
- E. Front Breaker Compartment:
1. The front breaker compartment is to contain the drawout circuit breaker elements, each mounted in its own barriered cell. Active or future use cells shall be equipped to accept circuit breaker

drawout mechanism and all current-carrying parts. Provide each breaker cell with a hinged door equipped with a flush handle and an external trip button. When equipped with a breaker, a barrier shall exist between operating personnel, the breaker mechanism and live parts.

2. Shutters shall be provided to shield live parts when circuit breaker is out for service. A barrier shall be provided for the opening in the circuit breaker compartment door to preclude the possibility of foreign objects entering the breaker cell when the breaker is removed.
- F. Center Bus Compartment:
1. The bus compartment is to contain the section riser and main cross bus which is to be rated for a 65°C temperature rise per ANSI standards. The main cross bus shall be rated for [3000] continuous amperes. All main and riser bus shall be bolted copper and adequately braced to withstand [65,000] symmetrical amperes short circuit current. All contact surfaces at bolted joints shall be fully silver plated and the joint bolts are to be of high strength grade 5 steel equipped with Belleville type spring washers. Riser bus shall meet industry standard phase-to-phase clearance. All electrical clearances are to be for 600 VAC. An isolated neutral a bus is to be supplied rated at 100 percent of the phase current.
- G. Rear Cable Compartment:
1. Size the cable compartment to accommodate all incoming and outgoing cable required within each vertical switchgear section. Cable lugs are to be mounted on the load side or line side as applicable run-back bus which is extended into this compartment from the bus compartment. Run-back bus for main or feeder breakers to be insulated from the section riser and cross bus. This compartment shall contain a copper ground bus isolated from the switchgear frame. Extend a neutral run-back into the cable compartment in each vertical section for connecting the neutral to the ground bus with a removable isolating link.
  2. The center bus compartment containing the section riser bus and main cross bus shall be segregated from the rear cable compartment by means of barriers.
- H. A Portable Testing and Calibration Device Shall be Provided.
- I. Circuit Monitor and Control System:
1. A Circuit Monitor and Control System with integral display shall be provided for each breaker. The system shall be a commercially off the shelf system, not a special assembly of diverse components.
  2. The Circuit Monitor and Control System shall be a multifunctional digital instrumentation, data acquisition and control device.
  3. The device shall provide the following metering functions sensing true RMS values:
    - a. Ammeter, and Voltmeter
    - b. Wattmeter and Varmeter
    - c. KVA Meter
    - d. Power Factor Meter

- e. Frequency Meter
  - f. Watthour Meter with Demand
4. The system shall communicate between the following:
- a. Circuit Monitor and Control System devices and the EMCS system provided under Division 15. Communications shall be over a single communications cable using the industry standard RS-485 data communications protocol.
5. The system shall include current transformers and potential transformers sensing all three phases.
6. The system shall be fully integrated into the Automatic Control System for full functionality.
- J. Automatic Control System (ACS) Components:
- 1. Components prescribed in other portions of these specifications shall be factory installed as indicated on the drawings.
  - 2. All interlocking and Input/Output Module wiring shall be type TBS with individual mechanical wire markers and terminated on terminal blocks at top of enclosure where shipping joints and connections to remote equipment occur.
  - 3. Ventilation fans with filters, if required, shall be provided in the sections housing the ACS components.
- K. All feeder connections shall be the compression lug type connectors.
- L. Current Transformers: Current transformers shall have a metering accuracy class rating of .3 for up to a B-.05 burden. Thermal and mechanical ratings of current transformers and their primary leads shall be consistent with the switchgear design and shall not be less than the momentary rating of the associated circuit breaker. Unless otherwise indicated, bar wound, or window type transformers are acceptable. Transformers shall be insulated for the rated voltage of the switchgear. Transformer secondaries shall not be connected to any terminal of a terminal block that is not of the short-circuiting type.
- M. Potential Transformers: Potential transformers shall be drawout type having current limiting fuses in both primary and secondary circuits. Mechanical interlocks shall prevent removal of fuses, unless the associated transformer is in the drawout position. Transformer compartments shall have hinged doors.
- 2.4 Circuit Breakers, General
- A. Breakers shall be as indicated on the drawings.
  - B. Tripping sensors shall be as indicated.
  - C. The circuit breakers shall be the drawout type, as shown on the drawings. The breakers shall be rated 100% for group mounted installations. The breakers are to mount on a rigid, self-aligning drawout mechanism with "connected", "test", "disconnected", and "removed" positions. The front door shall be capable of being closed in the "connected", "test" or "disconnected" positions.

- D. Provide interlocks to ensure the breaker is open before it can be moved from any position or when it is between positions. Include an interlock to discharge the stored energy spring before the breaker element can be withdrawn from its cell. In the "test" and "connected" positions, provide a positive ground contact between the breaker element and the structure.
- E. Breakers of like frame sizes shall be interchangeable. All circuit breaker operating mechanisms are to be fully stored energy devices with a two-step stored energy quick-make, quick-break. Actuation of the operating handle or an operation cycle of the breaker motor is to charge the closing springs, and operation motor is to charge the closing springs, and operation of a local "close" button is to close the breaker contact. Closing of the breaker contacts shall automatically charge the opening springs to ensure quick-break operation.
- F. Low voltage power breaker arc chutes containing asbestos will not be accepted.
- G. The circuit breaker trip device is to be of a solid state design which required no external power connections and is provided with an adjustable long-time delay, instantaneous and short-time delay over-current/short circuit protection. Rating plugs shall be interchangeable. Include ground fault tripping as an integral part of the solid-state trip device with  $I^2T$  function. The device shall be full RMS sensing. Settings are to be continuous between calibrated points. Provisions for testing and calibrating shall be provided. Indicators for overload, short circuit and ground trip shall be provided. Breakers are to have UL Label.
- H. The system shall be provided with zone selective interlocking allowing downstream breakers to restrain the upstream breakers during short circuit or ground fault.
- I. Padlocking provisions shall be furnished to receive up to three padlocks when breaker is in the open position, positively preventing unauthorized closing of the breaker contacts.
- J. A manual trip button and position indicator shall be furnished on all breakers. "Push to Close" button shall be conveniently located on face of breaker for easy access, thereby avoiding the need to reach behind or around other devices located on the face of the breaker.

## 2.5 PROTECTIVE RELAYS

- A. The protective relays shall be provided in the breaker sections. The protective relays shall be located in the cubicle above the associated breaker. Provide the protective relays as prescribed in these specifications.
- B. In addition to the prescribed protective relays each breaker shall be equipped with a solid state trip unit. The unit shall be the Micrologic full function trip system, or approved equal.
- C. Main Breaker: An individual power circuit breaker compartment shall be provided for the main utility breaker. The main breaker protective relays control compartment shall be located above the main utility

circuit breaker compartment and shall contain the associated protective relaying, potential and current transformers. [The Main Breaker Control Compartment shall contain:

1. Reverse power relays (Device 32).
  2. Phase reversal relay (Device 47).
  3. Over and Under frequency relays (Device 81 O/U).
  4. Main utility circuit breaker lockout relay (Device 86).]
  5. All fuses, fuse blocks, terminal trips, control wiring, nameplates, etc, as required.
  6. All additional protective relaying and/or control logic and interlocking as required by Local Service Provided.
- D. Feeder Breakers: An individual power circuit breaker compartment shall be provided for the feeder breakers. The feeder breaker compartment and shall contain the associated components, potential and current transformers. The Feeder Breaker Control Compartments shall contain:
1. Required current and potential transformers.
  2. All fuses, fuse blocks, terminal strips, control wiring, nameplates, etc., as required.
  3. The tripping and closing control power source shall be 24 VDC.

## 2.6 TERMINAL BLOCKS

- A. A minimum of 20 percent spare terminal blocks shall be provided and distributed amount the occupied terminal blocks.
- B. No more than two wires per terminal point shall be attached to each terminal block. Looping of wires from connection to connection is not permitted.
- C. A 24 VDC source will be available for control voltage.
- D. Provide engraved nameplates according to specification section 16195 identification. Submit a nameplate schedule to the Architect/Engineer for approval.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Installer must examine areas and conditions under which drawout switchgear and components are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

### 3.2 INSTALLATION

- A. Install drawout switchgear as indicated, in accordance with manufacturer's written instructions, with recognized industry practices; complying with applicable requirements of NEC, NEMA's Std PB 2.1, and NECA's "Standard of Installation".

- B. Coordinate with other work including electrical cabling/wiring work, as necessary to interface installation of drawout switchgear with other work.
  - C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std 486A.
  - D. Install fuses in drawout switchgear, if any.
- 3.3 ADJUSTING AND CLEANING
- A. Adjust operating mechanisms for free mechanical movement.
  - B. Touch-up scratched or marred surfaces to match original finishes.
- 3.4 GROUNDING
- A. Provide equipment grounding connections for drawout switchgear as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective ground. Provide ground bus of ampacity equal to at least 30% of main bus rating.
- 3.5 FIELD QUALITY CONTROL
- A. Prior to energization of circuitry, check all accessible connections to manufacturer's tightening torque specifications.
  - B. Prior to energization of drawout switchgear, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
  - C. Prior to energization, check drawout switchgear for electrical continuity of circuits, and for short-circuits.
  - D. Subsequent to wire and cable hook-ups, energize drawout switchgear and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.
- 3.6 TESTING
- A. The switchgear shall be fully assembled at the factory and complete operational tests be performed.
  - B. All tests may be witnessed by the Architect/Engineer at its discretion.
- 3.7 DEVICE COORDINATION
- A. Determine device trip settings by executing a coordination study. Trip settings shall be set to isolate faults and overcurrents to the branch breakers. Set pick-up levels such that load devices will trip first, feeder breakers next, and the mains will trip last.

- B. Coordinate between the main breakers, generator breakers, and the feeder breakers such that all breakers hold-in for the in-rush current, but the feeder breakers will trip first on overcurrent, instantaneous and ground fault.

END OF SECTION

## SECTION 16452

## GROUNDING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Extent of grounding work is indicated by drawings, schedules and as specified herein.
- B. Types of grounding specified in this section include the following:
  - 1. Solid grounding.
- C. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

## PART 2 - PRODUCTS

## 2.1 GROUNDING SYSTEMS

- A. Materials and Components:
  - 1. General: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, crimp type lugs, compression type lugs, grounding rods/electrodes, bonding jumper braid and additional accessories needed for complete installation. Where more than one type unit meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.
- B. Conductors: Provide copper electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC. All conduits shall contain a minimum of one separate equipment grounding conductor identified and sized according to NEC.
- C. Bonding Jumper Braid: Copper braided tape, constructed of 30-gage bare copper wires and properly sized for indicated applications.
- D. Connectors, Terminals and Clamps: Provide electrical connectors, terminals, lugs and clamps as recommended by connector, terminal and clamp manufacturers for indicated applications.
- E. Ground Rods:
  - 1. Standard Ground Rods: Steel with copper welded exterior, 3/4" dia. x 10' (Unless otherwise noted).
- F. Inspection Wells:

1. Standard Well: The standard inspection well shall be constructed of poly plastic material and shall be rated for indoor and outdoor use. The assembly shall be able to withstand light traffic and the cover shall be bolted in place. The cover shall be vented and labeled as grounding. The assembly shall be mounted flush with the finished grade/material. The assembly shall be at least 10" deep and 9" wide.
- G. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.
- H. Exothermic Welded Connections: Comply with AWS Code for procedures, appearance, and quality of welds; and methods used in correcting welding work. Provide welded connections where grounding conductors connect to underground rods, electrodes, cables and equipment.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Installer must examine areas and conditions under which electrical grounding connections are to be made and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to installer.

#### 3.2 INSTALLATION OF ELECTRICAL GROUNDING

- A. General: Install electrical grounding systems where shown, in accordance with applicable portions of NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
- B. The equipment grounding conductor shall be connected directly to the equipment grounding screw provided on receptacles.
- C. At switch outlets, where self-grounding type switches are installed in metal boxes, the equipment grounding conductor shall be connected directly to the metal box.
- D. Coordinate with other electrical work as necessary to interface installation of electrical grounding system with other work.
- E. Weld grounding conductors to underground grounding rods/electrodes. (Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable).
- F. Install clamp-on connectors only on thoroughly cleaned metal contact surfaces, to ensure electrical conductivity and circuit integrity.
- G. Install all ground rods (standard or chemical) in an enhanced backfill material such as Bentonite. Provide a minimum of 4" around the entire rod.

- H. Rods installed in electrical rooms and communication rooms shall be provided with inspection wells.
- I. The secondary of all interior transformers shall be bonded to a proven ground source.

### 3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 10 ohms, take appropriate action to reduce resistance to 10 ohms, or less. If necessary drive additional ground rods or provide chemically enhance rods, then connect them together with #4/0 bare copper grounding wire. Retest to demonstrate compliance. Coordinate any rework required with the CO/COR prior to beginning work.

END OF SECTION



## SECTION 16470

## PANELBOARDS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Extent of panelboard and enclosure work, including cabinets and cutout boxes is indicated by drawings and schedules.
- B. Types of panelboards and enclosures in this section include the following:
  - 1. Lighting and appliance type panelboards.
- C. Refer to other Division-16 sections for cable/wire, connectors, and electrical raceway work required in conjunction with panelboards and enclosures; not work of this section.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements of this specification.

## 2.2 PANELBOARDS

- A. General: Except as otherwise indicated, provide panelboards, enclosures and auxiliary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes, or ratings are not indicated, comply with NEC, UL and established industry standards for those applications indicated.
- B. Lighting and Appliance Panelboards: Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown; with anti-turn compression type lug connectors approved for copper or aluminum conductors; equip with copper bus bars, full-sized neutral bar, with bolt-on type heavy-duty, quick-make, quick-break, single-pole or multi-pole circuit-breakers, as indicated, with toggle handles that indicate when tripped. Multi-pole breakers shall be provided with a common trip. Provide suitable lugs on neutral bus for each outgoing feeder required; provide bare un-insulated grounding bars suitable for bolting to enclosures. Provide additional isolated ground bus where required.
  - 1. Lighting and Appliance Panelboards shall be bolt-on type.
  - 2. Breakers in 240 volt panelboards shall be fully rated and shall have an interrupting capacity of not less than 10,000 amperes

- symmetrical or as indicated on the drawings, which ever is greater.
3. Breakers in 480 volt panelboards shall be fully rated and shall have an interrupting capacity of not less than 14,000 amperes symmetrical or as indicated on the drawings, which ever is greater.
- C. Lighting and Appliance Panelboard Enclosures: Provide galvanized sheet steel cabinet type enclosures, minimum 20" wide and 5-3/4" deep, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush metal locks and keys, all panelboard enclosures keyed alike. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for recessed or surface mounting as indicated. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate properly with panelboards to be enclosed, and are NEMA rated to suit the atmospheric conditions of the equipment surroundings.
1. Furnish six spare keys for each type of panelboard cabinet lock.
- D. Panelboard Accessories:
1. Provide Door in Door construction devices
  2. Ground-fault protection units as indicated.
  3. Shunt trip units as indicated.
  4. Breaker handle locking clips, for all breakers feeding fire alarm and security loads.

### PART 3 - EXECUTION

#### 3.1 INSPECTION

- A. Installer must examine areas and conditions under which panelboards and enclosures are to be installed, and notify Contractor in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

#### 3.2 INSTALLATION OF PANELBOARDS

- A. General: Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate installation of panelboards and enclosures with cable and raceway installation work.
- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B or Manufacturer's torque requirements when more stringent.

- D. Anchor enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
- E. Provide properly wired electrical connections within enclosures.
- F. Provide panelboard circuit directory cards upon completion of installation work. Circuit directory cards shall be arranged with even numbered circuits separated by group or card from odd numbered circuits. All circuits, including spares and spaces, shall be labeled. All identification shall be at a minimum typewritten. Hand lettering is not acceptable.
- G. All wiring within panelboards shall be arranged in a neat and organized manner.

### 3.3 GROUNDING

- A. Provide equipment grounding connections for panelboards as required by NEC and other Division-16 sections. Tighten connections to comply with tightening torques specified in UL Stds 486A and B to assure permanent and effective grounds.

### 3.4 FIELD QUALITY CONTROL

- A. Prior to energizing circuitry, check all accessible connections to manufacturer's tightening torque specifications.
- B. Prior to energizing panelboards, check with ground resistance tester phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- C. Prior to energizing, check panelboards for electrical continuity of circuits, and for short-circuits.
- D. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION



## SECTION 16477

## FUSES

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Extent of fuse work is indicated by drawings and schedules.
- B. Types of fuses specified in this section include the following:
  - 1. Class RK1 time-delay.
  - 2. Class RK5 time-delay.
  - 3. Plug fuses.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements of this specification.

## 2.2 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time/current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and construction in accordance with published product information, and with industry standards and configurations.
- B. Class RK1 Time-Delay Fuses: Provide UL Class RK1 time-delay fuses rated 250V (Type LPN-RK) for voltages under 250V and 600V (Type LPS-RK) for voltages 250-600 V, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for sizes 100 thru 600 amperes.
- C. Class RK5 Time-Delay Fuses: Provide UL Class RK5 time-delay fuses rated 250V (Type FRN-R) for voltages under 250V and 600V (Type FRS-R) for voltages 250-600 V, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for sizes .1 thru 90 amperes.
- D. Plug fuses shall be permitted only for single-pole fuse holder with switch units. Plug fuses shall be dual-element Type S fuses.

## PART 3 - EXECUTION

## 3.1 INSTALLATION OF FUSES

- A. Install fuses as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of fuses.

- B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of fuses with other work.
- C. Install fuses in fused switches, if any.
- D. Short-circuit protection dual-element fuses installed in individual motor circuits with separate overload protection shall be sized at 150% of motor nameplate current rating or the next standard fuse size. Where excessive ambient temperature, high inertia motor loads or frequent "on-off" cycling requires larger fuses, consult the electrical engineer. Use fuse reducers where fuse gaps are larger than fuse dimension.
- E. All fuse sizes shall be coordinated with manufacturer's requirements for each unit of equipment to be connected.

### 3.2 FIELD QUALITY CONTROL

- A. Prior to energizing fusible devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

END OF SECTION