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Hanford Waste Vitrification Plant
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START

FLUOR DANIEL, INC.
Advanced Technology Division
Fluor Contract 8457

ELECTRICAL SITE UTILITIES
SPECIFICATION B-595-C-A170

"APPROVED FOR CONSTRUCTION"

REVISION NO. 0
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ELECTRICAL SITE UTILITIES
(B-595-C-A170)

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SECTION 01730
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUBMISSION OF OPERATION AND MAINTENANCE DATA

Submit operation and maintenance (O&M) data which is specifically applicable to this contract and a complete and concise depiction of the provided equipment or product. Data containing extraneous information to be sorted through to find applicable instructions will not be accepted. Present information in sufficient detail to clearly explain user O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit the following in accordance with the Vendor Drawing and Data Requirements section of the Order/ Subcontract.

1.1.1 Package Content

For each product, system, or piece of equipment requiring submission of O&M data, submit the package required in the individual technical section. Package content shall be as required in the Paragraph 1.3, "Schedule of Operations and Maintenance Data Packages."

1.2 TYPES OF INFORMATION REQUIRED IN O&M DATA PACKAGES

1.2.1 Operating Instructions

Include specific instructions, procedures, and illustrations for the following phases of operation:

1.2.1.1 Safety Precautions

List personnel hazards and equipment or product safety precautions for all operating conditions.

1.2.1.2 Operator Prestart

Include requirements to set up and prepare each system for use.

1.2.1.3 Start-Up, Shutdown, and Post-Shutdown Procedures

Include a control sequence for each of these operations.

1.2.1.4 Normal Operations

Include control diagrams with data to explain operation and control of systems and specific equipment.

1.2.1.5 Emergency Operations

Include emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.

1.2.1.6 Operator Service Requirements

Include instructions for services to be performed by the operator such as lubrication, adjustments, and inspection.

1.2.1.7 Environmental Conditions

Include a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which equipment should not be allowed to run.

1.2.2 Preventive Maintenance

Include the following information for preventive and scheduled maintenance to minimize corrective maintenance and repair.

1.2.2.1 Lubrication Data

Include lubrication data, other than instructions for lubrication in accordance with Paragraph 1.2.1.6, Operator Service Requirements.

1.2.2.2 Preventive Maintenance Plan and Schedule

Include manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair. Provide manufacturer's projection of preventive maintenance man-hours on a daily, weekly, monthly, and annual basis.

1.2.3 Corrective Maintenance

Include manufacturer's recommendations on procedures and instructions for correcting problems and making repairs.

1.2.3.1 Troubleshooting Guides and Diagnostic Techniques

Include step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

1.2.3.2 Wiring Diagrams and Control Diagrams

Wiring diagrams and control diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to actual installation numbering.

1.2.3.3 Maintenance and Repair Procedures

Include instructions and list tools required to restore product or equipment to proper condition or operating standards.

1.2.3.4 Removal and Replacement Instructions

Include step-by-step procedures and list required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.

1.2.3.5 Spare Parts and Supply Lists

Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays.

1.2.3.6 Corrective Maintenance Man-Hours

Include manufacturer's projection of corrective maintenance man-hours. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.

1.2.4 Appendices

Provide information specified in the preceding paragraphs pertinent to the maintenance or operation of the product or equipment. Include the following:

1.2.4.1 Parts Identification

Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirement to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

A. Manufacturer's Standard Commercial Practice: The parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as a master parts catalog, in accordance with the manufacturer's standard commercial practice.

B. Other Than Manufacturer's Standard Commercial Practice (MSCP): End item manufacturer may add a cross-reference to implement components' assemblies and parts requirements when implementation in manual form varies significantly from the style, format, and method of manufacturer's standard commercial practice. Use the format in the following example:

End Item Manufacturer's Alphanumeric Sequence	Actual Manufacturer's Name and MSCP	Actual Manufacturer Part No.
100001	John Doe & Co. 00000	2000002

1.2.4.2 Warranty Information

List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force.

1.2.4.3 Personnel Training Requirements

Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.

1.2.4.4 Testing Equipment and Special Tool Information

Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.

1.3 SCHEDULE OF OPERATION AND MAINTENANCE DATA PACKAGES

Furnish the O&M data packages specified in individual technical sections. The required information for each O&M data package is as follows:

1.3.1 Data Package

A. Operating instructions

B. Safety precautions

C. Operation prestart

D. Start-up, shutdown, and post shutdown

E. Normal operations

F. Emergency operations

G. Operator Service Requirements

H. Environmental conditions

I. Preventative maintenance

J. Lubrication data

K. Preventive maintenance plan and schedule

L. Corrective maintenance

M. Troubleshooting guides and diagnostic techniques

N. Wiring diagrams and control diagrams

O. Maintenance and repair procedures and manhour requirements

P. Removal and replacement instructions

Q. Spare parts and supply list

R. Parts identification

S. Warranty information

T. Personnel training requirements

U. Testing equipment and special tool information

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

(Not Used)

END OF SECTION

SECTION 02220
EXCAVATION AND BACKFILL

PART 1 GENERAL

1.1 SUMMARY

This section covers the technical requirements for excavation, backfill and compaction for the installation of foundations and underground utilities as shown on the Contract Drawings.

1.2 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D1556	1982 Standard Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D1557	1978 Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 pound (4.54 kg) Rammer and 18 inch (457 mm) Drop
ASTM D2167	1984 Standard Test Method for Density and Unit Weight of Soil In-Place by the Rubber Balloon Method
ASTM D2922	1981 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

WASHINGTON ADMINISTRATIVE CODE (WAC)

WAC	Chapter 296-155, Section 650-664, Excavation, Trenching and Shoring

1.3 RELATED REQUIREMENTS

Specification Section 16100 Electrical Installation

1.4 **SUBMITTALS**

Submittals by the Seller are not required for this specification section. The Buyer shall ensure the following information is provided:

1.4.1 Documentation providing the moisture density relationships, as specified in Paragraph 3.2.2.4A, for each type of soil used for backfill.

1.4.2 Documentation of field density tests, as specified in Paragraph 3.3, including the location and depth of each sample taken shall be by the Buyer.

1.5 **PROJECT OR SITE ENVIRONMENTAL CONDITIONS**

The upper 8 to 12 feet of the existing subgrade consists of soils which can be described as light brown silt and very fine to fine sand. The work area is overlain with 4 inches of crushed rock surfacing.

PART 2 PRODUCTS

2.1 **MATERIALS AND EQUIPMENT**

2.1.1 Backfill Material

2.1.1.1 Backfill materials shall be the originally excavated material or imported granular earth material, unless such material is determined to be unsuitable due to presence of vegetation, excessive moisture, refuse or other deleterious substances.

2.1.1.2 Sand used for backfill shall be a natural sand, graded from fine to coarse, not lumpy or frozen, with 100 percent passing a No. 4 sieve and 0 to 5 percent passing a No. 200 sieve. The sand shall be free from organic material, slag, cinders, ashes, and other refuse.

2.1.1.3 Fine gravel used for backfill shall be a natural gravel having particles in a reasonable uniform combination with 100 percent passing a 3/4 inch sieve and 0 to 5 percent passing a No. 4 sieve. The gravel shall be free from organic material, slag, cinders, ashes, and other refuse.

2.1.1.4 Notwithstanding the above requirements, gradation and particle size of imported granular fill material shall be controlled such that the laboratory and field testing required under Paragraphs 3.2.2.4A and 3.3 herein can be performed in accordance with the specified ASTM test methods.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Prior to Excavation

A. Obtain permission to excavate from the Buyer.

B. Determine the lines, grades and elevations for the installation of slabs at grade, foundations, underground utilities and appurtenances as shown on the Contract Drawings.

C. Determine the depth of excavation required for the installation of foundations, underground utilities and appurtenances as shown on the Contract Drawings.

D. Supply and set stakes to provide strict and accurate vertical and horizontal control of the work from monuments and benchmarks provided by the Buyer.

E. Locate and identify all underground utilities and tie-in points within the work area.

F. Existing crushed rock surfacing shall be removed as required and stockpiled in a location approved by the Buyer.

G. Grade the top perimeter of the excavation to prevent surface water from draining into the excavation.

3.1.2 Prior to Backfilling

A. Obtain permission to backfill from the Buyer.

B. All excavations shall be cleaned of trash and debris.

C. All exposed and excavated surfaces for equipment foundations shall be compacted with machine or hand operated compactors to not less than 95 percent of its maximum dry density as determined by ASTM D1557. A minimum of four passes shall be made before testing the compaction.

D. At locations beneath slabs at grade, foundations and appurtenances do not begin backfill operations until after the subgrade has been inspected and approved by the Buyer.

E. Backfilling operations over foundations and appurtenances may not begin until the below grade construction has been inspected and accepted by the Buyer.

F. Backfilling operations over foundations and appurtenances may not begin until the concrete has cured for at least 7 days and the forms have been removed. In addition, do not backfill against subsurface concrete walls until the walls have reached their specified 28 day compressive strength as demonstrated by compression testing of molded concrete cylinders.

G. Backfilling operations for utility trenches shall not begin until the installed utilities have undergone all required tests and inspections and have been accepted by the Buyer.

3.2 INSTALLATION, APPLICATION AND ERECTION

3.2.1 Excavation

3.2.1.1 General

A. All excavations shall be in accordance with Washington Administrative Code (WAC), Chapter 296-155, Section 650-664, "Excavation, Trenching and Shoring" and other applicable federal, state and local safety regulations. The side slopes at all excavations shall not be steeper than 1.8 horizontal to 1 vertical unless shoring is provided.

B. Precautions shall be taken as not to damage the existing underground utilities during excavation.

C. Excavation shall be by the open-cut method.

D. Keep all excavations free of water, ice, and debris.

E. An imaginary 45° line extending downward and outward from the bottom corner of any existing foundation shall not intersect any intended excavation for adjacent foundations, utilities or appurtenances, unless noted otherwise on the Contract Drawings.

F. When freezing temperatures are expected, do not excavate to the full depth indicated on the Contract Drawings unless the bottom of the excavation is adequately protected from frost.

G. Excess excavated material meeting the requirements of Paragraph 2.1.1.1 shall be stockpiled at a location designated by the Buyer for later use as backfill material.

Material excavated for the installation of underground utilities which have been determined suitable for backfill may be stockpiled in an orderly manner at a distance from

the banks of the trench equal to 1/2 the depth of the excavation, but no closer than 2 feet.

H. Material determined to be unsuitable for backfill shall be disposed in an area designated by the Buyer.

3.2.1.2 Excavation for Foundations and Slabs at Grade

A. Requirements specified in Paragraph 3.2.1.1 herein shall apply. Additional requirements shall be as specified below.

B. The excavation shall be made to the size and depth required to install the concrete foundations and slabs at grade to the lines and elevations shown on the Contract Drawings.

C. The excavation shall extend a sufficient distance from concrete walls and footings to allow the placement and removal of forms and inspection, except where the concrete is to be deposited directly against excavated surfaces or shoring.

D. Compact all exposed surfaces in accordance with Paragraph 3.1.2.C.

3.2.1.3 Excavation for Utility Trenches

A. Requirements specified in Paragraph 3.2.1.1 herein shall apply. Additional requirements shall be as specified below:

B. Excavate trenches to a width and depth required to install underground utilities as shown on the Contract Drawings.

C. Accurately grade the bottoms of trenches to provide uniform bearing and support for underground ductbanks and compact in accordance with Paragraph 3.1.2.C.

3.2.1.4 Dewatering

A. Excavate in such a manner that the work area will be effectively drained. Drainage shall be by gravity whenever possible; utilize additional means when necessary, including pumping and bailing.

B. Divert and/or pump out, bail or otherwise remove any water which may accumulate in the excavations, and perform all necessary work to keep them free from water while construction under this contract is being completed.

C. Obtain approval from the Buyer for discharge of water removed by any means.

3.2.2 Backfilling

3.2.2.1 General

A. Backfill material shall meet the requirements specified in Paragraph 2.1.1 herein.

B. Jetting of backfill is not permitted.

C. Backfill material shall be placed in maximum loose lifts of 8 inches and be compacted in accordance with Paragraph 3.2.2.3B.

D. Backfill material shall be moisture conditioned to within plus or minus 2 percent of its optimum moisture content as determined in Paragraph 3.2.2.3A. Disking or other mechanical mixing may be required to obtain the required moisture content since water applied to the surface will not penetrate the full depth of the lift.

E. Do not operate heavy equipment for spreading and compacting backfill within 5 feet of below-grade walls. The fill within this 5 foot strip shall be placed in maximum loose lifts of 6 inches and be compacted with a vibrating plate compactor, or drum compactor with a total static weight not exceeding 3000 pounds.

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ted, replace the original crushed rock surfacing and compact in accordance with Paragraph 3.2.2.3B.

3.2.2.2 Backfilling of Utility Trenches

A. Requirements specified in Paragraph 3.2.2.1 herein shall apply. Additional requirements shall be as specified below:

B. Direct burial cables shall be bedded in a cushion of sand not less than 3 inches on all sides. Direct burial conduit shall be buried directly in earth.

C. From the top of the bedding material to a depth of not less than two feet over direct burial wires, conduit and cables, backfill in maximum loose lifts of 6 inches and compact in accordance with Paragraph 3.2.2.3B. Compaction shall be achieved through the use of hand tamping or a power operated hand vibrating compactor such as a vibrating plate compactor

or drum compactor with a total static weight not exceeding 3000 pounds.

D. Deposit backfill material in the trench for its full width on each side of the utility and appurtenances simultaneously. Use special care in placing this portion of the backfill, so as to avoid damage or movement of the utility.

E. Place underground markers and wood boards over underground utilities per Specification Section 16100, Electrical Installation and as shown on the Contract Drawings.

F. Place the remainder of the backfill material in maximum loose lifts of 8 inches and compact in accordance with Paragraph 3.2.2.3B.

3.2.2.3 Compaction of Backfill

A. The moisture density relationship, as determined in accordance with ASTM D1557, shall be developed by the Buyer for each type of soil used for backfill. The optimum moisture content for the onsite soil is estimated to be 10 percent.

B. Compact each lift to a minimum of 90 percent of its maximum dry density as determined in Paragraph 3.2.2.3A at utility trenches and general area. Backfill placed under foundations and slabs at grade shall be compacted to a minimum of 95 percent of its maximum dry density.

Compact the crushed rock surfacing by at least two passes of a vibratory compactor approved by the Buyer.

3.2.3 Tolerances

Final grading elevations after excavation and backfill shall be within plus or minus 2 inches of the elevations shown on the Contract Drawings.

3.3 **FIELD QUALITY CONTROL**

3.3.1 The Buyer shall be responsible for field tests to determine that the work is performed in accordance with this specification. The Seller shall support and coordinate its work with Buyer's testing activities.

3.3.2 Field density tests shall be performed in accordance with ASTM D1556, ASTM D2167 or ASTM D2922. When tests are performed by the Nuclear Method per ASTM D2922, at least 20 percent of the tests shall be with ASTM D1556 or ASTM D2167 methods.

3.3.3 Field density tests are required for each method of compaction utilized, for each type of backfill material used.

3.3.4 The minimum number of field density tests shall be as follows:

A. Below foundations and slabs at grade; 1 test, per lift, per 1500 square feet of area with a minimum of one test at each installation.

B. Over and adjacent to foundations and slabs at grade; 1 test, per lift, per 3000 square feet of area with a minimum of one test at each installation.

C. Trenches; 1 test, per lift, per 200 lineal feet of trench.

3.3.5 Any areas failing to meet compaction requirements shall be recompacted and retested. If required compaction cannot be obtained, the material shall be retested, replaced, recompacted and tested.

END OF SECTION

SECTION 03300
CONCRETE CONSTRUCTION

PART 1 GENERAL

1.1 SUMMARY

This section covers the technical requirements for the furnishing, installation, inspection and testing of cast-in-place concrete and reinforcing steel.

1.2 REFERENCES

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

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	1989 Specification for Structural Concrete for Buildings
ACI 305R	1989 Hot Weather Concreting
ACI 306R	1988 Cold Weather Concreting
ACI SP-66	1988 ACI Detailing Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A615	1990 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C31	1990 Standard Test Method for Making and Curing Concrete Test Specimens in the Field
ASTM C33	1990 Standard Specification for Concrete Aggregates
ASTM C39	1986 Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	1990 Standard Specification for Ready-Mixed Concrete

ASTM C143	1990 Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	1989 Standard Specification for Portland Cement
ASTM C172	1990 Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	1978 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C260	1986 Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494	1986 Standard Specification for Chemical Admixtures for Concrete

1.3 **SUBMITTALS**

Submit the following in accordance with the Vendor Drawing and Data Requirements section of the Order/Subcontract.

1.3.1 Cast-in-Place Concrete

1.3.1.1 Materials

Material test reports for all concrete materials and admixtures to demonstrate conformance to the specification requirements.

1.3.1.2 Mix Design

Concrete mix design to demonstrate conformance to the specification requirements.

1.3.1.3 Placement Schedule

Concrete placement schedule per Paragraph 3.2.3.2.

1.3.1.4 Jobsite Records

Jobsite records of placed concrete per Paragraph 3.2.3.7.

1.3.1.5 Test Reports

Reports of field tests as specified in Paragraph 3.3.2 for slump, air content and compression shall be by the Buyer.

1.3.2 Reinforcing Steel

Certified Mill Test Report documenting the conformance of the materials as specified in Paragraph 2.3.

PART 2 PRODUCTS

2.1 CAST-IN-PLACE CONCRETE

2.1.1 Cement: ASTM C150; Type I or Type II

2.1.2 Aggregates: ASTM C33; Maximum size of coarse aggregate shall be 1 inch unless noted otherwise on the Contract Drawings.

2.1.3 Water: Shall be clean and potable meeting the requirements of ASTM C94. In addition, the water shall not contain more than 250 ppm of chloride as Cl.

2.1.4 Admixtures if used shall conform to the following requirements:

2.1.4.1 Air Entrainment: ASTM C260; MB-VR manufactured by Master Builders, Inc. or equal.

2.1.4.2 Water Reducing: ASTM C494, Type A; Pozzolith 220-N manufactured by Master Builders, Inc. or equal.

2.1.5 Concrete Mix

2.1.5.1 Mix concrete in accordance with ACI 301, Chapter 7. Deliver concrete in accordance with ASTM C94.

2.1.5.2 Select proportions for normal weight concrete in accordance with ACI 301, Chapter 3.

2.1.5.3 Concrete shall conform to the following requirements:

Compressive Strength (28 days):	4,000 psi, minimum
W/C Ratio:	W/C ratio not to exceed 0.5
Slump:	2 to 4 inches
Air Entrainment:	As required per mix design, not to exceed 4 percent

2.1.5.4 Use accelerating admixtures in cold weather only when approved by the Buyer. Use of admixtures will not relax cold weather placement requirements.

2.1.5.5 Use of calcium chloride is not permitted.

2.1.5.6 Use set retarding admixtures during hot weather only when approved by the Buyer.

2.1.5.7 Admixtures used in the work shall be of the same composition as those used in establishing the concrete properties.

2.1.5.8 Storage of materials shall be per Section 2.5 of ACI 301.

2.2 **CONCRETE FOR DIRECT BURIAL CABLE**

Concrete for direct burial cable under roads shall comply to the requirements specified above for cast-in-place concrete except as noted below.

Compressive Strength (28 days):	2500 psi, minimum
Maximum Aggregate Size:	3/8 inch
Cement per cubic yard of concrete:	4 sacks, minimum

2.3 **REINFORCING STEEL**

ASTM A615, 60 ksi yield grade; deformed billet steel bars, plain finish.

2.4 **CONCRETE ACCESSORIES**

2.4.1 All accessories and devices associated with the installation of concrete construction shall be supplied in accordance with this specification and the requirements shown on the Contract Drawings.

2.4.2 Tie Wire: Minimum 16 gauge, black, annealed type.

2.4.3 Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during concrete placement.

2.4.4 Special Chairs, Bolsters, Bar Supports, Spacers adjacent to Weather Exposed Concrete Surfaces: Plastic coated steel type; size and shape as required.

2.5 **FABRICATION AND MANUFACTURE**

2.5.1 Fabricate reinforcing steel in accordance with ACI SP-66 and to the dimensions shown on the Contract Drawings.

2.5.2 Bend bars cold in a manner that will not injure the material.

2.5.3 Store reinforcing steel off the ground and protect from oil or other deleterious materials.

2.5.4 Rust, seams, surface irregularities, or mill scale shall not be cause for rejection, provided the weight and height of deformations of a hand-wired-brush test specimen are not less than that specified by ASTM A615.

2.5.5 Tag bundles of reinforcing bars showing quantity, grade, size, and suitable identification to allow checking, sorting and placing.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Prior to concrete placement, verify that the concrete cover is as shown on the Contract Drawings. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, securely positioned as shown on the Contract Drawings.

3.1.2 Construction joints shall be prepared in accordance with ACI 301, Section 6.1 and Section 8.5.3.

3.1.3 Remove laitance and concrete splatter from protruding reinforcing steel after each concrete placement.

3.1.4 Continue all reinforcement across construction joints. Do not use longitudinal keys and inclined dowels.

3.1.5 All equipment for mixing and transporting concrete shall be clean.

3.1.6 All debris and ice shall be removed from spaces to be occupied by concrete.

3.1.7 Forms shall be properly coated in accordance with Section 4.4 of ACI 301.

3.1.8 Reinforcement shall be thoroughly clean of ice, earth, loose rust and mill scale or other deleterious coatings.

3.1.9 Standing water shall be removed from place of deposit before concrete is placed.

3.1.10 All laitance and other unsound material shall be removed before additional concrete is placed against hardened concrete.

3.2 INSTALLATION, APPLICATION AND ERECTION

3.2.1 Formwork

Formwork design, installation and removal shall be in accordance with ACI 301, Chapter 4. Form exposed corners of structures and foundations with a one inch chamfer unless noted otherwise on the Contract Drawings.

3.2.2 Placing Reinforcement

3.2.2.1 Place, support and secure all reinforcement to prevent displacement from its required position. Reinforcement placing tolerances shall meet the requirements of ACI 301 Chapter 5. Bars shall be tied securely to prevent displacement and all dowels shall be securely held in place prior to depositing concrete.

3.2.2.2 When necessary to move reinforcing bars to avoid interference with other reinforcement, conduits, or embedded items exceeding the specified placing tolerances, the resulting arrangement of bars shall be subject to acceptance by the Buyer.

3.2.3 Placing Concrete

3.2.3.1 Place concrete in accordance with ACI 301, Chapter 8, except as modified by the supplemental requirements herein.

3.2.3.2 Prepare concrete placement schedule for each concrete pour for Buyer's approval. The schedule should address the following items:

A. Pour number;

B. Extent of pour, plan and elevation views;

C. Volume of concrete;

D. Reference to applicable submitted concrete mix design.

3.2.3.3 Do not use equipment made of aluminum alloys for pump lines, tremies, or chutes used to discharge concrete from a truck mixer.

3.2.3.4 Concrete shall not be cast against any frozen surface.

3.2.3.5 When the ambient temperature is below 40°F or expected to be below 40°F within 24 hours of concrete placement, the provisions of ACI 306R shall be followed.

3.2.3.6 When the ambient temperature is above 90°F or expected to be above 90°F at time of concrete placement, the provisions of ACI 305R shall be followed.

3.2.3.7 Maintain a jobsite record of placed concrete. Record date, time, location, quantity, air temperature, concrete temperature, delivery slip number, cylinder sample numbers and pour number.

3.2.4 Concrete Finishing

3.2.4.1 Finish formed surfaces in accordance with ACI 301, Chapter 10, except as modified by the supplemental requirements herein.

3.2.4.2 Formed surfaces not exposed to earth shall have a "smooth form finish."

3.2.4.3 Formed surfaces exposed to earth may have a "rough form finish."

3.2.4.4 Slabs shall have a "broom finish" and maintaining surface flatness within 1/4 inch in 10 feet as determined by a 10 foot straight edge placed anywhere on the slab in any direction.

3.2.5 Curing and Protection

Cure and protect concrete in accordance with ACI 301, Chapter 12.

3.2.6 Repair of Surface Defects

Repair of surface defects shall be performed only with the approval of the Buyer and shall be performed in accordance with ACI 301, Chapter 9.

3.3 **FIELD QUALITY CONTROL**

3.3.1 General

3.3.1.1 The Buyer shall be responsible for the field testing of concrete to determine the work is performed in conformance to this specification and drawings.

3.3.1.2 Prior to the placement of any cast-in-place concrete the Seller shall meet with the Buyer and a representative from the testing agency designated by the Buyer. A procedure shall be developed for the gathering, handling and transporting of the required samples by the testing agency and for the submittal of the test results to the Buyer.

3.3.1.3 The responsibilities and duties of the Seller are as defined in ACI 301, Section 16.7.

3.3.2 Testing

3.3.2.1 Sampling and testing of concrete shall be in accordance with ACI 301, Chapter 16, except as modified by the supplemental requirements herein.

3.3.2.2 Concrete test samples shall be taken at or near the point of final deposit.

3.3.2.3 Concrete slump tests shall meet the requirements of ASTM C143. Perform a slump test concurrently with the preparation of molded test cylinders.

3.3.2.4 Concrete air content tests shall meet the requirements of ASTM C173. Perform air content tests concurrently with the preparation of molded test cylinders.

3.3.2.5 Molded cylinders for compression tests shall be prepared in sets of three meeting the requirements of ASTM C31. Composite samples shall be secured in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis. Curing shall meet the requirements of ASTM C31 for the standard 7 day and 28 day tests.

3.3.2.6 The minimum sampling frequency shall be one set for each 100 cubic yards, or fraction thereof, per day for each mix design.

3.3.2.7 Compression testing of cylinders shall meet the requirements of ASTM C39. Test each set of three cylinders as follows:

A. One cylinder at 7 days.

B. The remaining two cylinders at 28 days.

C. The acceptance test results shall be the average of the two specimens tested at 28 days per ACI 301, Paragraph 16.3.4.3.

3.3.3 Inspection

3.3.3.1 The inspection of reinforcing bar placement, concrete cover, formwork preparation and position of embedded items for compliance with the Contract Drawings shall be done prior to the placement of the concrete.

3.3.3.2 The concrete shall be inspected immediately upon the removal of the forms for excessive honeycombs or embedded debris. Repair of surface defects shall be performed in accordance with ACI 301, Chapter 9.

3.3.4 Evaluation and Acceptance

The evaluation and acceptance of the concrete work shall meet the requirements of ACI 301, Chapters 17 and 18.

END OF SECTION

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SECTION 16100
ELECTRICAL INSTALLATION

PART 1 GENERAL

1.1 SUMMARY

1.1.1 This specification section and the Contract drawings shall govern the installation of the electrical systems on the project. In case of conflict with this specification and the Contract Drawings, the specification shall govern. They are intended to identify all materials and equipment required to assemble the facilities. Any deviation from this specification and/or Contract Drawings must be authorized in advance by the Buyer.

1.1.2 Furnish all labor, material, tools and equipment necessary to perform installation of electrical site utilities as shown on the Contract Drawings and in accordance with the requirements of this specification.

1.1.3 Seller shall be responsible for field routing and/or matching of equipment wiring and conduit to components where not specifically defined on the Contract Drawings.

1.1.4 The project includes the installation of the following:

1.1.4.1 Lighting for temporary and permanent parking lots and roadways.

1.1.4.2 Construction power system including rerouting of existing 13.8 kV and 2.4 kV overhead distribution lines, 13.8 kV switchgear, 13,800-480/277V transformers, 480-208/120V transformers, 480/277V distribution switchboards and associated conduits, cable and materials.

1.1.4.3 Telephone interface cabinet for construction telephone service.

1.2 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2 1990 National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 1990 National Electrical Code (NEC)

1.3 **RELATED REQUIREMENTS**

Specification Section 16110 Electrical Materials and Devices

Specification Section 16905 Electrical Testing

1.4 **SUBMITTALS**

1.4.1 Submit the following in accordance with the Vendor Drawing and Data Requirements section of the Order/Subcontract.

1.4.2 Manufacturer's instructions for installation of 480/277V distribution switchboards, poles, luminaires and any other miscellaneous items identified in this specification and as shown on the Contract Drawings. Manufacturer's instructions shall include connection diagrams and any additional procedures for equipment storage, handling, protection, examination, preparation and start-up.

1.4.3 Sag and tension data obtained during the installation of overhead cable.

1.5 **PROJECT OR SITE ENVIRONMENTAL CONDITIONS**

1.5.1 Climatic and Geographic Site Conditions

A. Site Elevation 714 feet above sea level

B. Barometric Pressure 14.3 psia

C. Outside Design Temperature

1) Maximum Design Temperature 110°F

2) Minimum Design Temperature -20°F

1.5.2 Operating Environment

A. Normal Temperature -20° to 110°F

PART 2 PRODUCTS

2.1 **MATERIALS AND/OR EQUIPMENT**

Furnish all materials and equipment required to perform installation work in accordance with the Contract Drawings and Specification Section 16110.

PART 3 EXECUTION

3.1 INSTALLATION, APPLICATION AND ERECTION

3.1.1 Equipment and materials shall be installed in accordance with NFPA 70 and ANSI C2. Installation shall conform with the Contract Drawings and manufacturer's instructions furnished with equipment and materials.

3.1.2 Fastenings

3.1.2.1 Unless noted otherwise on the Contract Drawings, fastenings to steel shall be by means of machine screws, bolts or certified and approved welding method. No wood or fiber plugs shall be permitted.

3.1.2.2 Seller shall drill, tap, or weld to structural steel as required to mount equipment and material using an approved or specified method.

3.1.2.3 Seller shall supply and install electrical supports as shown on the Contract Drawings.

3.1.3 Grounding

3.1.3.1 The grounding of electrical equipment, personnel operated equipment and grounded electrical circuits shall be in accordance with the Contract Drawings. In addition to the grounding specified herein or on the Contract Drawings, all ground connections required by the National Electrical Code shall be furnished and installed. Where grounding conductor sizes are not indicated on the Contract Drawings, the minimum requirements of the National Electrical Code shall apply.

3.1.3.2 Before connections are made, all contact surfaces shall be clean of grease, dirt and debris.

3.1.3.3 All ground connections shall be exothermic welds as shown on the Contract Drawings.

3.1.3.4 The grounding of the 480-208/120V pad mounted transformers shall be similar to the 13,800-480/277V transformer and switchboard assembly as detailed on the Contract Drawings. The grounding shall consist of a 5/8 inch steel ground loop, two (2) ground rods located at opposing corners, and one (1) 5/8 inch steel tap from the loop to the equipment enclosure. In addition, the circuit ground shall be connected to the equipment enclosures.

3.1.4 Power Transformers

3.1.4.1 Power transformers shall be installed in accordance with manufacturer's instructions and as shown on the Contract Drawings. The following additional precautions shall be taken:

3.1.4.1.1 Inspect for external damage and to assure that the no-load tap changer is in position.

3.1.4.2 The 480/208V pad mounted transformers for the start-up trailers shall be field located.

3.1.5 Switchgear and Switchboards

3.1.5.1 Switchgear and switchboards shall be installed in accordance with manufacturer's instructions. The following additional precautions shall be taken:

3.1.5.1.1 Store indoors in a clean, dry place with a moderate temperature and cover with plastic tarp. Install and activate space heaters inside units. Space heaters shall be kept energized or thermostatically controlled to temperatures above the dew point while in storage and after installation.

3.1.5.1.2 Torque all bus bolts to manufacturer's recommendations.

3.1.6 Lighting System

3.1.6.1 Wire smaller than No. 12 AWG shall not be used for any lighting branch circuits.

3.1.6.2 Lighting fixtures shall be installed at locations as shown on the Contract Drawings.

3.1.6.3 Route lighting circuits underground with direct buried cable. Cable shall be protected with 1 by 8 inch wood boards as shown on the Contract Drawings. Boards shall be treated with an approved factory applied preservative.

3.1.6.4 Install marking tape within backfill above wood board(s) as shown on the Contract Drawings.

3.1.6.5 Light poles shall be installed plumb. Use shims or double nuts to adjust plumb. Grout around each light pole base as shown on the Contract Drawings.

3.1.7 Medium Voltage

3.1.7.1 Medium voltage cable shall be spliced and terminated in accordance with the recommendations of the manufacturer of the cable. Splices shall be made in manholes, pull boxes, handholes or junction boxes as shown on the Contract Drawings.

3.1.7.2 Direct burial cable shall be protected by 1 by 8 inch boards as shown on the Contract Drawings. Boards shall be treated with an approved factory applied preservative.

3.1.7.3 Medium voltage termination kits shall be installed in accordance with manufacturer's recommendations.

3.1.7.4 Plastic marking tape shall be placed in the backfill directly above the direct burial cable approximately 12 inches below grade as shown on the Contract Drawings.

3.1.8 Overhead Cables

3.1.8.1 Overhead cable shall be spliced and terminated in accordance with the recommendations of the manufacturer of the cable.

3.1.9 Poles

3.1.9.1 Steel Poles

3.1.9.1.1 Steel poles shall be installed in accordance with the recommendations of manufacturer and as shown on the Contract Drawings.

3.1.9.2 Wood Poles

3.1.9.2.1 Wood poles shall be installed in accordance with the recommendations of manufacturer and as shown on the Contract Drawings.

3.1.9.2.2 The minimum setting depth for poles shall be according to the following:

POLE LENGTH FEET	SETTING DEPTH
45	6'-6"
40	6'-0"

3.1.10 Overhead Distribution

3.1.10.1 Guys and Anchors

3.1.10.1.1 Guys shall be placed before the conductors are strung and shall be attached to the pole as shown on the Contract Drawings.

3.1.10.1.2 All anchors and rods shall be in line with the strain and shall be installed as shown on the Contract Drawings.

3.1.10.2 Splices and Dead-Ends

Conductors shall be spliced and dead-ended as shown on the Contract Drawings. There shall be not more than one splice per conductor in any span and splicing sleeves shall be located at least ten feet from the conductor support.

3.1.10.3 Taps and Jumpers

Jumpers and other leads connected to line conductors shall have sufficient slack to allow free movement of the conductors.

3.1.10.4 Sag and Tension

Overhead conductors shall be installed in accordance with the Contract Drawings, Attachment A and manufacturer's sag and tension data. Ensure final sag applied is within tolerances of plus 3 inches to minus 0 inches. The sag shall be adjusted per manufacturer's sag tables for the temperature at the time of installation. Buyer shall be notified before final adjustments to the sag are made.

3.1.10.4.1 Record and supply to the Buyer the details of the sagging process giving the following details:

Length of section
Actual span of section
Date of sagging
Temperature at time of sagging
and either
Actual sag of conductors
Actual spans used in sagging
Or
Wire tension

3.1.10.5 Crossarms

Crossarms shall be installed in accordance with Contract Drawings.

3.1.10.6 Miscellaneous Hardware

Miscellaneous hardware for the overhead distribution, such as surge arresters and fused interrupter switches shall be installed in accordance with the manufacturer's installation instructions.

3.1.10.7 Underground Cable Marker

Install underground cable marker with arrow parallel to and facing underground run. Arrows shall point from the source to the point of utilization. Markers shall be placed one foot from the edge of the underground run and placed at 150 foot intervals on straight runs. At each turning point or tee, one marker shall be placed for each direction the cable or duct takes at that point.

3.1.11 Painting

3.1.11.1 Electrical equipment that may have been abraded during installation shall be touched up. Touch-up paint for switchgear and power transformers shall be supplied by the Buyer. Touch-up paint for switchboards shall be supplied by the Seller.

3.1.12 Open conduit ends shall have bushings unless other terminations are shown on the Contract Drawings. Sealant shall be used as required.

3.2 **FIELD QUALITY CONTROL**

Electrical materials and equipment shall be inspected and tested in accordance with Specification Section 16905, Electrical Testing.

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ATTACHMENT A

SAG AND TENSION DATA

CONDUCTOR: #2 AWG 7/1 STRANDING, SPARATE

				INITIAL		FINAL	
SPAN (FT)	TEMP (F)	WIND (PSF)	ICE (IN)	SAG (FT)	TENSION (LB)	SAG (FT)	TENSION (LB)
100	15	4	1/4	.61	1232	.61	1232
	60	0	0	.15	910	.17	794
	120	0	0	.27	492	.40	337
150	15	4	1/4	1.30	1289	1.30	1289
	60	0	0	.33	910	.39	774
	120	0	0	.60	504	.87	347
200	16	4	1/4	2.20	1354	2.20	1354
	60	0	0	.59	910	.71	750
	120	0	0	1.03	519	1.49	359
250	15	4	1/4	3.28	1422	3.28	1422
	60	0	0	.92	910	1.15	726
	120	0	0	1.56	535	2.24	372
300	15	4	1/4	4.51	1491	4.51	1491
	60	0	0	1.32	910	1.71	702
	120	0	0	2.18	552	3.12	384

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ATTACHMENT A

SAG AND TENSION DATA

CONDUCTOR: #4 AWG 6/1 STRANDING, SWAN

				INITIAL		FINAL	
SPAN (FT)	TEMP (F)	WIND (PSF)	ICE (IN)	SAG (FT)	TENSION (LB)	SAG (FT)	TENSION (LB)
100	15	4	1/4	.99	669	.99	669
	60	0	0	.15	465	.20	354
	120	0	0	.27	269	.51	141
150	15	4	1/4	2.04	729	2.04	729
	60	0	0	.35	465	.50	322
	120	0	0	.59	274	1.09	148
200	16	4	1/4	3.34	792	3.34	792
	60	0	0	.62	465	.99	291
	120	0	0	1.02	280	1.85	155
250	15	4	1/4	4.85	853	4.85	853
	60	0	0	.96	465	1.70	264
	120	0	0	1.56	287	2.74	163
300	15	4	1/4	6.54	911	6.54	911
	60	0	0	1.39	465	2.64	245
	120	0	0	2.19	294	3.77	171

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ATTACHMENT A

SAG AND TENSION DATA

CONDUCTOR: 336.4KCMIL 30/7 STRANDING, ORIOLE

				INITIAL		FINAL	
SPAN (FT)	TEMP (F)	WIND (PSF)	ICE (IN)	SAG (FT)	TENSION (LB)	SAG (FT)	TENSION (LB)
100	15	4	1/4	.26	5492	.26	5492
	60	0	0	.15	4325	.17	3814
	120	0	0	.24	2745	.35	1882
150	15	4	1/4	.58	5530	.58	5530
	60	0	0	.34	4325	.39	3809
	120	0	0	.53	2777	.77	1930
200	16	4	1/4	1.01	5579	1.01	5579
	60	0	0	.61	4325	.69	3802
	120	0	0	.94	2818	1.33	1989
250	15	4	1/4	1.57	5640	1.57	5640
	60	0	0	.95	4325	1.08	3796
	120	0	0	1.44	2865	2.01	2054
300	15	4	1/4	2.23	5708	2.23	5708
	60	0	0	1.37	4325	1.56	3790
	120	0	0	2.03	2916	2.75	2157

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SECTION 16110
ELECTRICAL MATERIALS AND DEVICES

PART 1 GENERAL

1.1 SUMMARY

This specification section covers the technical requirements for furnishing and delivery of electrical materials and devices for construction power distribution.

1.2 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS2	1985 Structural Supports for Highway Signs, Luminaires and Traffic Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI 05.1	1987 Wood Poles - Specifications and Dimensions
ANSI 05.3	1989 Solid Sawn-Wood Crossarms and Braces - Specifications and Dimensions
ANSI B1.1	1989 Unified Inch Screw Threads
ANSI B18.2.1	1981 Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	1987 Square and Hex Nuts (Inch Series)
ANSI B18.6.3	1972 Machine Screws and Machine Screw Nuts
ANSI B18.22.1	1975 Plain Washers
ANSI C29.2	1983 Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.5	1984 Wet-Process Porcelain Insulators - Low and Medium Voltage Types

ANSI/IEEE C37.20.2	1987 Metal-Clad and Station-Type Cubicle Switchgear, Standard for
ANSI/IEEE C62.11	1987 Metal-Oxide Surge Arresters for AC Power Circuits, Standard for
ANSI C78.41	1987 Electric Lamps - Low Pressure Sodium Lamps
ANSI C82.9	1988 High Intensity Discharge and Low Pressure Sodium Lamps, Ballasts, and Transformers - Definitions
ANSI C119.1	1986 Electric Connectors - Sealed Insulated Underground Connector Systems Rated 600 Volts

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A36	1989 Standard Specification for Structural Steel
ASTM A153	1982 (R 1987) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	1990 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A475	1989 Standard Specification for Zinc Coated Steel Wire Strand
ASTM A500	1989 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM B3	1990 Standard Specification for Soft or Annealed Copper Wire
ASTM B8	1986 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B230	1989 Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes

ASTM B232	1986 Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated-Steel Reinforced (ACSR)
ASTM B498	1988 Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for aluminum Conductors, Steel Reinforced (ACSR)
ASTM F1135	1988 Standard Specification for Cadmium or Zinc Chromate Organic Corrosion Protective Coating for Fasteners

AMERICAN WOOD-PRESERVERS ASSOCIATION (AWPA)

AWPA C7	1990 Incised (Red, White and Yellow Cedar) Pole Butts, Thermal Treatment

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS6	1987 Specification for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 through 69 kV

FEDERAL SPECIFICATIONS (FS)

FS TT-P-645B	1990 Primer, Paint, Zinc-Molybdate, Alkyd Type

FEDERAL STANDARDS (FS)

FS-595B	1989 Colors Used in Government Procurement

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 48	1990 Standard for High Voltage AC Cable Terminations Test Procedures and Requirements
IEEE 404	1986 Standard for Cable Joints for use with Extruded Dielectric Cable Rated 5000V through 46,000V and Cable Joints for use with Laminated Dielectric Cable Rated 2500V through 500,000V

NATIONAL ELECTRIC MANUFACTURERS ASSOCIATION (NEMA)

NEMA LA1	1986 Surge Arresters
NEMA PB2	1989 Dead-Front Distribution Switchboards
NEMA RN1	1986 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA WC7	1988 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC8	1988 Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	1990 National Electrical Code (NEC)

UNDERWRITER'S LABORATORIES (UL)

UL 44	1983 Rubber Insulated Wires and Cables, Twelfth Edition
UL 198G	1988 Standard for Fuses for Supplementary Overcurrent Protection
UL 467	1984 Grounding and Bonding Equipment
UL 510	1986 Insulating Tape, Sixth Edition
UL 651	1989 Schedule 40 and 80 Rigid PVC Conduit, Fifth Edition
UL 891	1984 Dead-Front Switchboards
UL 1072	1986 Medium Voltage Power Cables
UL 1277	1989 List of Acceptable Sunlight-Resistant PVC Compounds for use as Insulating and/or Jacketing Material on Listed Outdoor Flexible Cords and Christmas-Tree Wire and Cords, Medium-Voltage Cable, Power and Control Tray Cable, and Metal Clad Cable

UL 1449	1985 Transient Voltage Surge Suppressors
UL 1581	1983 Reference Standard for Electrical Wires, Cables and Flexible Cords

1.3 **RELATED REQUIREMENTS**

Specification Section 01730	Operation and Maintenance Data
Specification Section 16100	Electrical Installation
Specification Section 16905	Electrical Testing

1.4 **SUBMITTALS**

Submit the following in accordance with the Vendor Drawing and Data Requirements section of the Order/Subcontract.

1.4.1 Manufacturer's Catalog Data including the following:

A. Splice Kit

B. PVC Conduit

C. Sealant

D. Fused Interrupter Switches

E. Insulating Tape

F. Marking Tape

G. Wood Boards

H. Ground Conductors

I. Ground Rods

J. Grounding Assembly

K. Ground Connectors

L. Anti-Oxidizing Compound

M. Exothermic Welds

N. Surge Arresters

O. Cable Termination Kits

P. Cable to Bus Connection Kits

Q. Wood Poles

R. 5 kV Crossarm Pin Insulator Assembly

S. 5 kV Dead-End Assembly

T. 15 kV Dead-End Insulator Assembly

U. Double Crossarm Assembly for Dead-End Loading

V. Down Guy Assembly

W. Horizontal Guy Assembly

X. Miscellaneous Pole Line Devices

Y. Exterior Lighting Assembly

Z. 600 Volt Power Cable

AA. Medium Voltage Cable

AB. Concrete Boxes

AC. Concrete Box Covers

AD. Concrete Cone Anchors

AE. Underground Cable Markers

AF. Hardware

AG. PVC Coated Rigid Steel Galvanized

AH. Guy Wire

1.4.2 Shop Drawings

1.4.2.1 Switchboard

Submit switchboard detailed shop drawings indicating outline dimensions, enclosure construction, shipping splits, lifting and supporting points, schematic single line diagrams, elementary and detailed connection diagrams and equipment electrical rating.

Also provide approximate position of overall vertical and horizontal center of gravity for unit, size and location of anchor bolts, hold down and/or base frame details and the shipping and operating weights.

1.4.2.2 Exterior Lighting Assembly

1.4.2.2.1 Luminaries

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, and candlepower distribution data.

1.4.2.2.2 Poles

Include dimensions, wind load withstand capability and maximum pole deflection under maximum loading conditions in accordance with AASHTO LTS2.

1.4.2.2.3 Anchor base and anchor bolt pattern details and criteria.

1.4.2.3 Power Cables

Submit detailed shop drawings indicating outline dimensions and assembly for the ACSR cable, enclosure construction, insulation and assembly for the direct burial cable.

1.4.2.3.1 Sag and Tension Data

Submit manufacturer's data for stringing sags and tensions. Span range shall be 100 to 350 feet at 50 foot intervals. Temperature range shall be -20°F to 110°F at 10° intervals.

1.4.3 Manufacturer's Installation Instructions for the following:

1.4.3.1 Switchboards

1.4.3.2 Fused Interrupter Switches

1.4.3.3 Surge Arresters

1.4.4 Test Reports

1.4.4.1 Power Cable

Submit Factory Certified Test Reports on 5 kV and 15 kV direct burial power cables and overhead conductors of bare aluminum conductor steel reinforced (ACSR) after performing factory acceptance tests in accordance with AEIC CS6 and ASTM B498 respectively as indicated in Paragraph 2.2.1.

1.4.5 Operation and maintenance data in accordance with Specification Section 01730, Operation and Maintenance Data.

1.5 **PROJECT OR SITE ENVIRONMENTAL CONDITIONS**

1.5.1 Climatic and Geographic Site Conditions

A.	Site Elevation	714 feet above sea level
B.	Barometric Pressure	14.3 psia
C.	Outside Design Temperature	
1)	Maximum Design Temperature	110°F
2)	Minimum Design Temperature	-20°F

1.5.2 Operating Environment

A.	Normal Temperature	-20° to 110°F

PART 2 PRODUCTS

2.1 **MATERIALS AND EQUIPMENT**

2.1.1 Splice Kit

Splice kits for low and medium voltage cables shall be waterproof and shall be in accordance with ANSI C119.1 and IEEE 404 respectively. Raychem RVS and HVS respectively or equal.

2.1.2 PVC Conduit

PVC conduit shall be Schedule 40 or Schedule 80, as shown on the Contract Drawings, in accordance with UL 651.

2.1.3 Sealant

Sealant for preventing moisture from entering conduits shall be a non-oxidizing and noncorrosive compound, Dow Corning 738 or equal.

2.1.4 Pole Mounted Fused Interrupter Switches

2.1.4.1 Fused interrupter switches shall be distribution class, 3 pole for outdoor operation. A disconnect stick shall be provided for switch operation.

2.1.4.2 Fused interrupter switches shall be outdoor type, rated 5 and 15 kV, 60 and 95 kV BIL respectively, 600 amp continuous, 40,000 amp momentary rating silver plated contacts with power fuse size as shown on the Contract Drawings. Fuses shall be in accordance with UL 198G. S&C switches with SMU-20 (15 kV) and SM-5 (5 kV) fuses or equal.

2.1.5 Switchboard

2.1.5.1 Switchboard assembly shall be of the outdoor dead-front distribution type, containing main circuit breaker, branch circuit breakers with the necessary accessory components, all completely factory assembled and operationally checked in accordance with NEMA PB2 and UL 891.

2.1.5.2 Switchboard shall be rated 480 volts, 3 phase, 4 wire and bus ampere capacity as shown on the Contract Drawings. Switchboard interrupting capability is 30,000 minimum amperes.

2.1.5.3 Switchboard busing shall be copper, based on 1000 amperes per square inch. Bus bars shall be rigidly braced to comply with the integrated equipment rating of the switchboard.

2.1.5.4 Entry of incoming and outgoing lines shall be through the bottom with cable sizes as shown on the Contract Drawings.

2.1.5.5 Main circuit breaker shall be adjustable thermal magnetic trip type with built-in ground fault protection with continuous breaker rating as shown on the Contract Drawings. Main circuit breaker shall be provided with double lugs at the line side of circuit breaker where specified on the Attachment A.

2.1.5.6 Branch circuit breakers shall be totally front accessible, thermal magnetic trip type with continuous breaker rating as shown on the Contract Drawings.

2.1.5.7 Switchboard enclosure size shall be provided large enough to accommodate the main and branch circuit breakers as shown on the Attachment A. Breakers shown with trip rating shall be supplied with the switchboard.

2.1.5.8 A lighting fixture with incandescent lamp and a switch shall be provided and shall be suitably located to provide adequate interior lighting.

2.1.5.9 Each switchboard and its feeder breakers shall have a nameplate as follows:

2.1.5.9.1 Nameplates shall be of laminated black and white plastic arranged to show black engraving on white background.

2.1.5.9.2 Nameplates sizes shall be 8 inch wide by 1-1/2 inch high for switchboards and 2-1/2 inch wide by 1-1/4 inch high for circuit breakers.

2.1.5.9.3 Nameplate letters and/or figures shall be 7/16 inch high for switchboards and 1/8 inch high for circuit breakers.

2.1.5.9.4 Nameplate descriptions shall be as shown on the Contract Drawings. Sample nameplates for the switchboard and feeder breakers are shown on the Attachment A.

2.1.5.9.5 Nameplates shall be mounted using stainless steel screws. Glued or "Press-On" type of fastening is not acceptable.

2.1.5.9.6 The switchboard nameplate shall be mounted in the center of the panel where the main circuit breaker is located and shall be spaced 1-1/2 inch from the top of the panel. The feeder breaker nameplates shall be mounted next to the side of the feeder breaker.

2.1.6 Tapes

2.1.6.1 Insulating Tape

Insulating tape shall be vinyl insulating type with a continuous temperature rating of 105°C, in accordance with UL 510. 3M Super 88 Series or equal.

2.1.6.2 Marking Tape

Plastic marking tape for identifying underground electrical cable shall be six inches wide, yellow color, without printing. Reef Industries Terra Tape or equal.

2.1.7 Wood Boards

Boards for protecting underground direct buried cable(s) shall be preservative treated, one inch thick by eight inches wide (nominal).

2.1.8 Ground Conductors

2.1.8.1 Steel Ground Conductors

Grounding cables shall be 7 strand, low carbon grade steel. Coating shall be Class B zinc in accordance with ASTM A475. The main grounding cables and interconnecting runs between ground systems shall be 5/8 inch diameter cable. Branch cables shall be 1/2 inch diameter cable minimum.

2.1.8.2 Copper Ground Conductors

Grounding cable shall be stranded or solid bare copper wire in accordance with ASTM B3. The sizes of the cable are as shown on the Contract Drawings.

2.1.9 Ground Rods

2.1.9.1 Steel Ground Rods

Ground rods shall be 5/8 inch diameter by 8 feet or 10 feet long galvanized steel as shown on Contract Drawings. Joslyn Number J5328 and J5330 or equal.

2.1.9.2 Copperbonded Ground Rods

Copperbonded ground rods shall be 5/8 inch diameter by 8 feet long and in accordance with UL 467. Carolina Catalog Number P588 or equal.

2.1.10 Grounding Assembly

Distribution grounding assembly shall be in accordance with Detail 6, Attachment B.

2.1.11 Ground Connectors

2.1.11.1 Steel Cable to Copper Lug

Steel ground cable to copper lug shall be CADWELD Type "GL" or equal.

2.1.12 Anti-Oxidizing Compound

Anti-oxidizing compound for connections of grounding connectors shall be electrically conductive, rust and corrosion inhibitive, Thomas and Betts Company "Kopr-Shield" or equal.

2.1.13 Exothermic Welds

All ground connections shall be Exothermic type, CADWELD or equal.

2.1.14 Surge Arresters

Surge arresters shall be 5 and 15 kV systems, 60 and 95 kV BIL respectively, distribution class in accordance with ANSI/IEEE C62.11, NEMA LA-1, UL-1449 and with NEMA type "A" bracket for crossarm mounting. Joslyn Catalog numbers J9221-QS and J9251-QS respectively or equal.

2.1.15 Cable Termination Kits

2.1.15.1 Cable termination kit for termination of 15 kV shielded copper conductor cables shall include stress relief cones and shall be in accordance with IEEE 48 and IEEE 404. The size and number of conductors of 15 kV shielded power cables shall be as shown on the Contract Drawings. Raychem HVT or equal.

2.1.15.2 Cable termination kit for termination of 5 kV non-shielded cables shall include insulating tubes and sealant and shall be suitable for outdoor installation. The termination kit shall be in accordance with IEEE 48. Raychem HVT-50 or equal.

2.1.16 Cable to Bus Connection Kits

Cable to bus connection kits shall be made in accordance with ANSI/IEEE C37.20.2. The size of cable shall be as shown on the Contract Drawings. Raychem HVBC or equal.

2.1.17 Wood Poles for Power Distribution

Wood pole shall include shaft and crossarm and shall be designed for the installation of fused interrupter switches and surge arresters.

2.1.17.1 Shaft

2.1.17.1.1 Shaft shall be 45 feet long ANSI Class 2 and shall consist of one piece Western Red Cedar cut round straight wood in accordance with ANSI 05.1. Shaft shall be butt treated and branded or marked in accordance with AWPA C7 and ANSI 05.1 respectively.

2.1.17.1.2 The pole roof and gain shall be factory coated with preservative solution. The top of each pole shall have a one-way roof cut sloping 30 degrees (120 degrees with pole axis) and the cut surface shall face at right angles to the pole face.

2.1.17.2 Wood Crossarms

Wood crossarms shall be as shown on the Contract Drawings, Attachment B and ANSI 05.3.

2.1.18 5 kV Crossarm Pin Insulator Assembly

5 kV crossarm pin insulator assembly shall consist of a pin type distribution insulator in accordance with ANSI C29.5, Class 55-2 and 5/8" x 6-1/2" long shank forged steel insulator pin, 8 inches high.

2.1.19 5 kV Dead-End Assembly

5 kV dead-end assembly shall consist of a suspension insulator, thimble clevis, eye nut and connector as shown on Detail 1, Attachment B.

2.1.20 15 kV Crossarm Pin Insulator Assembly

15 kV crossarm pin insulator assembly shall consist of a pin type insulator in accordance with ANSI C29.5, Class 55-5 and a 5/8" x 6-1/2" long shank forged steel insulator pin, 8 inches high.

2.1.21 Transformer Padmounts

Transformer padmounts for the 480-208/120V start-up trailer transformers shall be precast type. Padmounts shall be Edison Type 1, Quickset Catalog Number S-1.4-44-1 or equal.

2.1.22 15 kV Dead-End Insulator Assembly

15 kV dead-end insulator assembly shall consist of suspension insulators, strain clamp and eye nut as shown on Detail 2, Attachment B.

2.1.23 Double Crossarm Assembly for Dead-End Loading

Double crossarm assembly for dead-end loading shall consist of crossarms, crossarm braces, machine bolt, washers, carriage bolts, lag screws and double arming bolts as shown on Detail 4, Attachment B.

2.1.24 Down Guy Assembly

Down guy assembly shall consist of 7 guy strands, guy clamps, serving sleeves, strain insulator, pole band, single guy attachment, guy roller, plastic guy guard, anchor rod and helix type anchor as shown on Detail 7, Attachment B.

2.1.25 Horizontal Guy Assembly

7/16 inch utilities horizontal guy assembly shall consist of 7 guy strands, strain insulators, pole bands and single guy attachment as shown on Detail 7, Attachment B.

2.1.26 Miscellaneous Pole Line Devices

The following materials for the above assemblies shall be as specified below or equal:

Eye-Nuts	Chance Series 6500
Serving Sleeves	Chance Series 6450
Plastic Guy Guard	Joslyn #J1492Y
Threaded Forged-Eye Anchor Rods	Joslyn #J7540
Guy Roller	Hughes Bros #28082/3
Connecting Link	Hughes #3153
Pole Band	Hughes #3105
Guy Grip	Preformed #GDE-1108, BG-2115/6
Guy Clamps	Joslyn #J931
Double Arming Bolts	Joslyn Series #J8800
Machine Bolts	Joslyn Series #J8800, J8700, J8900
Carriage Bolts	Joslyn Series #J8600
Flat Steel Crossarm Braces	Joslyn #J7028
Wood Crossarm Brace	Joslyn #J5188, J5172
Thimble Clevises	Joslyn #J0555
Lag Screws	Joslyn #J8755
Galvanized Staple	Joslyn #J128
Copper-Coated Staple	Joslyn #J6493
Split Bolt Connector, Tinned	Burndy Type KSU
Ground Rod Clamps Galvanized	Joslyn #J8225
Plastic Ground Wire Molding	Joslyn #PM128
Galvanized Ground Rod	Joslyn #J5328
Copperbonded Ground Rod	Joslyn #P588
Ground Rod Clamps Copper	Burndy GRC58

2.1.27 Exterior Lighting Assembly

The pole, luminaire, lamp and bracket arm shall be an integral assembly of exterior lighting designed in accordance with the standards specified in this section and as shown on the Contract Drawings.

2.1.27.1 Luminaire

2.1.27.1.1 Luminaire shall be 95 percent or higher power factor, low pressure sodium, one lamp, 180 watt, 480V, single phase, pole mounted type with two inch slipfitter and clear flat lens, dual in-line fuses and individual photocell control.

2.1.27.1.2 Housing shall be constructed of formed and welded aluminum sheet with integral high power factor ballast in accordance with ANSI C82.9, rated for -20°F starting, enclosed and gasketed suitable for outdoor use. Each housing shall be finished with a zinc-molybdate primer coat, alkyd type, conforming to FS-TT-P-645B, and painted with a medium gray paint, Color No. 16492, pigmented alkyd gloss enamel in accordance with FS-595B. Spaulding Palomar LPS Series or equal.

2.1.27.2 Lamps

Low-pressure sodium (LPS) lamps shall meet ANSI C78.41 for 180 watt lamp type L74. Venture lighting Pro-Arc #76415 or equal.

2.1.27.3 Poles

2.1.27.3.1 Steel Poles

A. The pole assembly complete with luminaire in place shall be capable of withstanding a sustained wind velocity of 70 mph with gust wind velocity of 1.3 times the sustained wind velocity in accordance with AASHTO LTS2.

B. Steel poles shall be 30 feet long, square straight steel and shall include shaft, anchor base, handhole with cover, base cover, anchor bolts, leveling shims, and tenon for mounting two foot side arm with two inch slipfitter. Spaulding 30 foot, square, straight steel pole with finish to match luminaire.

C. Shaft shall be 30 feet long and shall consist of one piece square steel tubing in accordance with ASTM A500, Grade B. The shaft shall have a handhole, handhole cover and a terminal for grounding, accessible from the handhole in

accordance with National Electrical Code, NFPA 70. The pole shaft top shall be prepared to accept the specified luminaire and bracket arm.

D. Anchor base shall be circumferentially welded to the pole shaft. The tensile capacity of the weld attaching the shaft to the base shall exceed the tensile capacity of the shaft. The base shall be fabricated from carbon steel in accordance with ASTM A36.

E. Bracket arm shall be two foot side arm with two inch slip-fitter to match pole top tenon. An opening in the tenon mounting plate shall be part of the continuous wireway from the pole base to the luminaire. Bracket arm primer and paint shall match pole shaft and luminaire finishes. Bracket arm shall be furnished with hardware required for mounting luminaire with two inch slipfitter.

F. Anchor bolts shall be in accordance with ASTM A307, Grade C ASTM A36 and as shown on the Contract Drawing. Anchor bolt and hex nuts shall be galvanized in accordance with ASTM A153.

2.1.27.3.2 Wood Poles for Lighting

Wood pole shall include shaft and bracket arm and shall be designed for installation of two inch slipfitter type luminaire.

A. Shaft

1) Shaft shall be 40 feet long ANSI Class 4 and shall consist of one piece Western Red Cedar cut round straight wood in accordance with ANSI 05.1. Shaft shall be butt treated and branded or marked in accordance with AWPA C7 and ANSI 05.1 respectively.

2) The pole roof and gain shall be factory coated with preservative solution. The top of each pole shall have a one-way roof cut sloping 30 degrees (120 degrees with pole axis) and the cut surface shall face at right angles to the pole face.

B. Bracket Arm

Bracket arm shall be a standard steel luminaire support for wood poles. The steel luminaire support shall be hot dip galvanized in accordance with ASTM A153 for lasting protection from the elements and shall have a 2-1/2 foot horizontal length and 8 inch rise. Bracket arm shall be

furnished with ground lug assembly and hardware required for mounting luminaire with a two inch slipfitter. Joslyn Catalog Number J728003 or equal.

2.1.27.3.3 Stub Poles

A. Stub poles shall include shaft and shall be designed for pole support by using horizontal and down guys.

B. Shaft shall be 40 feet long ANSI Class 4 and shall consist of one piece Western Red Cedar cut round straight wood in accordance with ANSI 05.1. Shaft shall be butt treated and branded or marked in accordance with AWPA C7 and ANSI 05.1 respectively.

C. The pole roof and gain shall be factory coated with preservative solution. The top of each pole shall have a one-way roof cut sloping 30 degrees (120 degrees with pole axis) and the cut surface shall face at right angles to the pole face.

2.1.28 600 Volt Power Cable

2.1.28.1 General Requirements

2.1.28.1.1 Cable supplied shall be new, and shall be the product of an established manufacturer normally engaged in the production of cable, with a minimum of 5 years documented experience in the manufacture of cable.

2.1.28.1.2 Cable on each reel shall be continuous. Factory splices or factory repairs are not acceptable in individual conductors. Cable shall be free of abrasions and/or abnormalities.

2.1.28.2 Single Conductor Cable

2.1.28.2.1 Design Requirements

A. Cables herein specified shall be rated 600 volts, Type XHHW in accordance with National Electrical Code, NFPA-70, Article 310 and UL 44. The maximum continuous conductor temperature shall be 90°C for dry and 75°C for wet location. Okonite X-Olene Type XHHW or equal.

B. Cable sizes smaller than No. 8 shall be solid copper and the size No. 8 and larger shall be stranded copper.

2.1.28.2.2 Conductor

Conductor shall be uncoated, soft or annealed, bare copper wire in accordance with ASTM B3. Stranded conductors shall be Class B,

concentric stranded in accordance with Part 2 of NEMA WC7 and ASTM B8.

2.1.28.2.3 Conductor Insulation

The insulation shall be flame-retardant, heat and moisture resistant type of cross-linked-polyethylene compound. The insulation shall be in accordance with Part 3 of NEMA WC7.

2.1.28.2.4 Nominal insulation thickness and maximum wire diameter shall be as follows:

Conductor Size (AWG/KCMIL)	Minimum Insulation Thickness Mils	Maximum Wire O.D. Inches
12	30	0.15
750	80	1.18

2.1.28.3 Multiconductor Direct Burial Cable

2.1.28.3.1 General Requirements

Cables shall have a 600 volt rating. They shall be Type TC multiconductor cable suitable for direct burial in accordance with NFPA 70 (NEC) Articles 340 and 310, UL 1277 and UL 1581. All cables shall include an insulated ground wire. Okonite X-Olene-Okoseal Type TC cable or equal.

2.1.28.3.2 Conductor

Conductors shall be uncoated, annealed, bare copper wire in accordance with ASTM B3 and shall be Class B, concentric stranded in accordance with Part 2 of NEMA WC7 and ASTM B8.

2.1.28.3.3 Conductor Insulation

The conductor insulation shall be flame-retardant, cross-linked-polyethylene compound, type XHHW in accordance with NEMA WC7 and UL 44.

2.1.28.3.4 Nominal insulation thickness and maximum wire diameter shall be as follows:

Conductor Size (AWG)	Number of Conductors	Minimum Insulation Thickness Mils	Grdg Cond Size (AWG)	Maximum Cable O.D. Inches
10	4	30	1# 10	.58
8	4	45	1# 8	.72

2.1.28.3.5 Jacket

Overall jacket shall be polyvinyl chloride complying with UL 1277 and UL 1581 and shall be sunlight resistant and suitable for direct burial.

2.1.28.3.6 Conductor Identification

Conductors shall be color coded by pigmented insulation as indicated below:

A. Grounded neutral - Gray

B. Grounding conductor - Green

C. Phase "A" conductor - Brown

D. Phase "B" conductor - Orange

E. Phase "C" conductor - Yellow

2.1.29 Medium Voltage Cable

2.1.29.1 Underground Cable

2.1.29.1.1 15 kV Cable

A. General

The cable shall be shielded, copper, three conductor, rated 90°C for operation at a nominal 15 kV. The cable shall be suitable for direct burial, and shall be suitable for intermittent or continuous submersion in water.

B. Conductors

The cables shall have copper conductors with concentric lay Class B round stranding in accordance with the requirements of ASTM B8 and NEMA WC8. The conductor sizes shall be as indicated on the Contract Drawings.

C. Conductor Screen

The stress control layer shall be an extruded semiconducting ethylene-propylene rubber material meeting the requirements of NEMA WC8, AEIC CS6 and UL 1072.

D. Insulation

The primary insulation shall be 15 kV voltage class, ethylene-propylene rubber (133 percent insulation level). It shall meet the requirements of NEMA WC8, UL 1072 and AEIC CS6. The minimum average thickness of insulations shall be 220 mils. The minimum thickness at any point shall not be less than 90 percent of the minimum average.

E. Insulation Screen

The nonmetallic insulation screen shall be an extruded semi-conducting ethylene-propylene rubber material extruded directly over the insulation, and meeting the requirements of NEMA WC8, UL 1072 and AEIC CS6.

F. Metallic Shield

The extruded semi-conducting screen shall be covered with an uncoated copper shielding tape. It shall be applied helically with a 12-1/2 percent minimum overlap.

G. Cable Assembly

The three shielded conductors shall be cabled together with non-hydroscopic moisture resistant fillers and a bare copper grounding conductor in contact with the metal shielded tape between conductors. The cabled assembly shall have a left hand lay and shall provide a round substantially filled core covered by a binder tape overall.

H. Sheath

The three shielded conductors shall have a tight fitting, continuously welded, impervious, corrugated aluminum sheath applied over the cable core in accordance with UL 1072.

I. Grounding Conductor

The three shielded conductors shall have an equipment grounding conductor of uninsulated copper, Class B stranded per ASTM B8 inserted into cable assembly and in contact with metal shielding tape. The size of the equipment grounding conductor shall be equivalent to that shown on the Contract Drawings.

J. Overall Jacket

A continuous extruded jacket of moisture, heat, oil, and abrasion resistant black polyvinylchloride (PVC) meeting the

requirements of NEMA WC8 and UL-1072 shall be applied over the metallic shield. The minimum thickness at any point shall not be less than 80 percent of the minimum average value in accordance with NEMA WC8.

K. Conductor Identification

A colored mylar strip, black/red/blue, shall be placed longitudinally under the copper shield tape for phase identification.

2.1.29.1.2 5 kV Cable

A. General

The cable shall be copper, single conductor and rated 90°C.

B. Conductors

Conductors shall be concentric lay Class B round stranded in accordance with the requirements of ASTM B8 and NEMA WC8. The conductor sizes shall be as indicated on the Contract Drawings.

C. Conductor Screen

The stress control layer shall be an extruded semiconducting ethylene-propylene rubber material meeting the requirements of NEMA WC8, AEIC CS6 and UL 1072.

D. Insulation

The primary insulation shall be 5 kV voltage class, ethylene-propylene rubber (133 percent insulation level). It shall meet the requirements of NEMA WC8 and UL 1072. The minimum average thickness of insulations shall be 125 mils. The minimum thickness at any point shall not be less than 90 percent of the minimum average.

E. Overall Jacket

A continuous extruded jacket of moisture, heat, oil, and abrasion resistant polyvinylchloride (PVC) meeting the requirements of NEMA WC8 and UL-1072 shall be applied over the insulation. The minimum jacket thickness at any point shall not be less than 80 percent of the minimum average value in accordance with NEMA WC8.

2.1.29.2 Aerial Cable

2.1.29.2.1 General

The cable shall be suitable for overhead installation.

2.1.29.2.2 Conductors

The overhead cable shall be bare aluminum conductor steel reinforced (ACSR) with concentric lay stranded in accordance with ASTM B230, B232 and B498. The conductor type and class shall be as follows:

CONDUCTOR SIZE (AWG/KCMIL)	ACSR STRANDING	CLASS	CODE NAME	RATED BREAKING STRENGTH (POUNDS)
#2	7/1	AA-A	SPARATE	3640
#4	6/1	AA-A	SWAN	1800
336.4	30/7	AA	ORIOLE	17,300

2.1.30 Concrete Boxes

Concrete boxes shall be 12 inch diameter reinforced concrete. Brooks Products "PB" or equal.

2.1.31 Concrete Box Covers

Concrete box covers shall be bolt-down type marked with "GROUND" reinforced concrete for concrete ground box Brooks Products or equal.

2.1.32 Concrete Cone Anchors

Concrete cone anchors shall be rated for 3000 pounds per square inch compressive strength at 28 days. Cones shall have the following dimensions in inches:

Diameter of top	3±1/2
Diameter of bottom	24±1
Diameter of hole through axis	1-3/16±1/16
Height	16±1/2

Concrete cone anchors shall be Reese Concrete Product Manufacturing Co. anchor or equal.

2.1.33 Underground Cable Markers

Route markers shall be galvanized steel with a 3 inch steel helix welded to a 7/16 inch diameter rod. Attached to the rod shall be a 2 inch by 3/4 inch by 30 inch 10 gauge steel stake with a 4 inch by 7 inch steel identification plate mounted near the top. The designation "Cable" with a directional arrow shall be marked on face plate. AB Chance Catalog No. C554-0183.

2.1.34 Hardware

Hardware shall be cadmium plated steel in accordance with ASTM F1135 and the following:

Machine screws	ANSI B1.1, B18.6.3
Machine hex head nuts and bolts	ANSI B1.1, B18.2.1, B18.2.2, ASTM A307
Plain washers	ANSI B18.22.1

2.1.35 PVC Coated, Rigid Steel Galvanized

Polyvinyl-Chloride (PVC) externally coated galvanized rigid steel conduit shall be in accordance with NEMA RN-1.

2.1.36 Guy Wire

Guy wire shall be galvanized steel strand in accordance with ASTM A475.

2.2 **FABRICATION AND MANUFACTURE**

2.2.1 Factory Acceptance Test

2.2.1.1 Medium Voltage Cable

2.2.1.1.1 Each cable shall be subjected to factory tests both underground and overhead cables in accordance with AEIC CS6 and ASTM B498 respectively.

2.2.1.1.2 A certified copy of the actual production test values for both underground and overhead cables shall be provided in accordance with AEIC CS6 and ASTM B498 respectively.

PART 3 EXECUTION

3.1 **INSTALLATION, APPLICATION AND ERECTION**

Electrical materials and devices shall be installed in accordance with Specification Section 16100, Electrical Installation.

3.2 **FIELD QUALITY CONTROL**

Electrical materials and devices shall be inspected and tested in accordance with Specification Section 16905, Electrical Testing.

END OF SECTION

DATA SHEET

ELECTRICAL MATERIALS AND DEVICES

Specification No.: B-595-C-A170-16110

EQUIPMENT NO.: SB-32T
SERVICE: Switchboard
CONTRACT NO.: 845734
PROJECT: HWVP
BY: R. A. HUR DATE: 03/18/91
REV.: 0 DATE:
CUSTOMER: DOE

1. SB-32T-001

   A. Main Circuit Breaker
      1600AT*

   B. Branch Circuit Breakers
      8 - 250AF
      4 - 100AF
      1 - 250AT
      1 - 150AT
      1 - 30AT
      1 - 25AT
      1 - 15AT

2. SB-32T-002

   A. Main Circuit Breaker
      1600AT*

   B. Branch Circuit Breakers
      4 - 250AF
      4 - 100AF
      1 - 250AT
      1 - 150AT
      2 - 25AT
      3 - 20AT

3. SB-32T-003

   A. Main Circuit Breaker
      1600AT

   B. Branch Circuit Breakers
      13 - 250AF

*Double Lugs
AT: Amp Trip
AF: Amp Frame (Space only)

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DATA SHEET

EQUIPMENT NO.: SB-32T
SERVICE: Switchboard
CONTRACT NO.: 845734
PROJECT: HWVP
BY: R. A. HUR DATE: 03/18/91
REV.: 0 DATE:
CUSTOMER: DOE

ELECTRICAL MATERIALS AND DEVICES

Specification No.: B-595-C-A170-16110

4. SB-32T-004

   A. Main Circuit Breaker
      1600AT

   B. Branch Circuit Breakers
      1 - 1600AT
      3 - 250AF
      1 - 100AF
      1 - 20AT

5. SB-32T-005

   A. Main Circuit Breaker
      1600AT

   B. Branch Circuit Breakers
      4 - 250AF
      3 - 125AT
      1 - 100AF
      5 - 20AT

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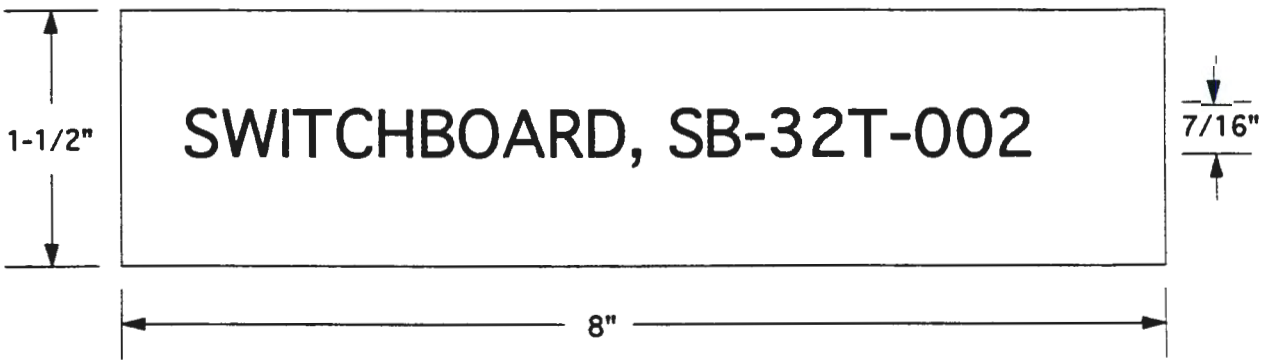
DATA SHEET

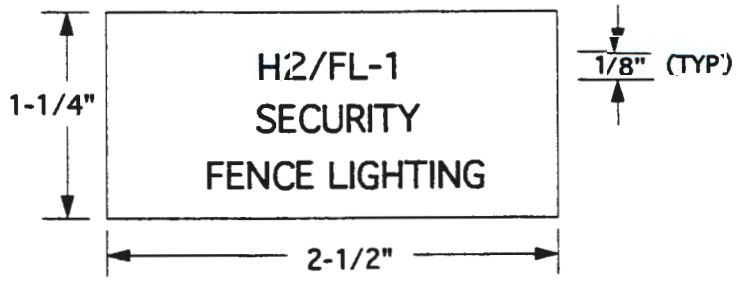
ELECTRICAL MATERIALS AND DEVICES

Specification No.: B-595-C-A170-16110

EQUIPMENT NO.: SB-32T
SERVICE: Switchboard
CONTRACT NO.: 845734
PROJECT: HWVP
BY: R. A. HUR DATE: 03/18/91
REV.: 0 DATE:
CUSTOMER: DOE

SAMPLE NAMEPLATES
NOT TO SCALE





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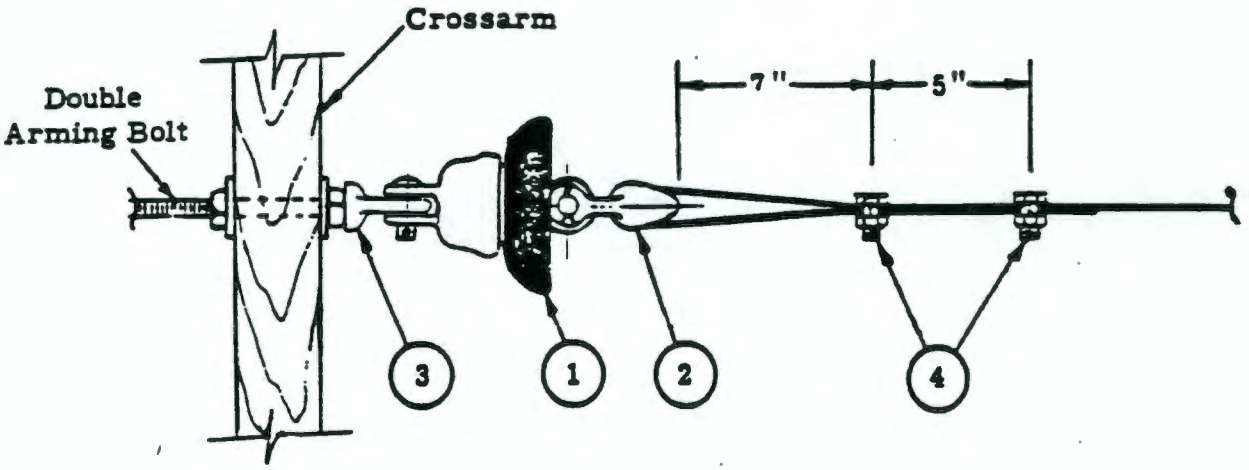

BILL OF MATERIAL		
ITEM NO.	Qty	DESCRIPTION
1	1	Insulator - Suspension, ANSI C29.2, Class 52-1
2	1	Thimble Clevis, Galvanized Forged Steel
3	1	Eye Nut - 5/8" §*
4	2	Connector - Split Bolt, Tinned

* Hardware shall conform to American National Standard Institute.

§ Use 5/8" eye nut (item 3) with conductors No. 1/0 Awg and smaller. For heavier construction, use 3/4" eye nut, or 3/4" double arming eye bolts.

PRIMARY DEAD-END ASSEMBLY, 5 kV
DETAIL 1

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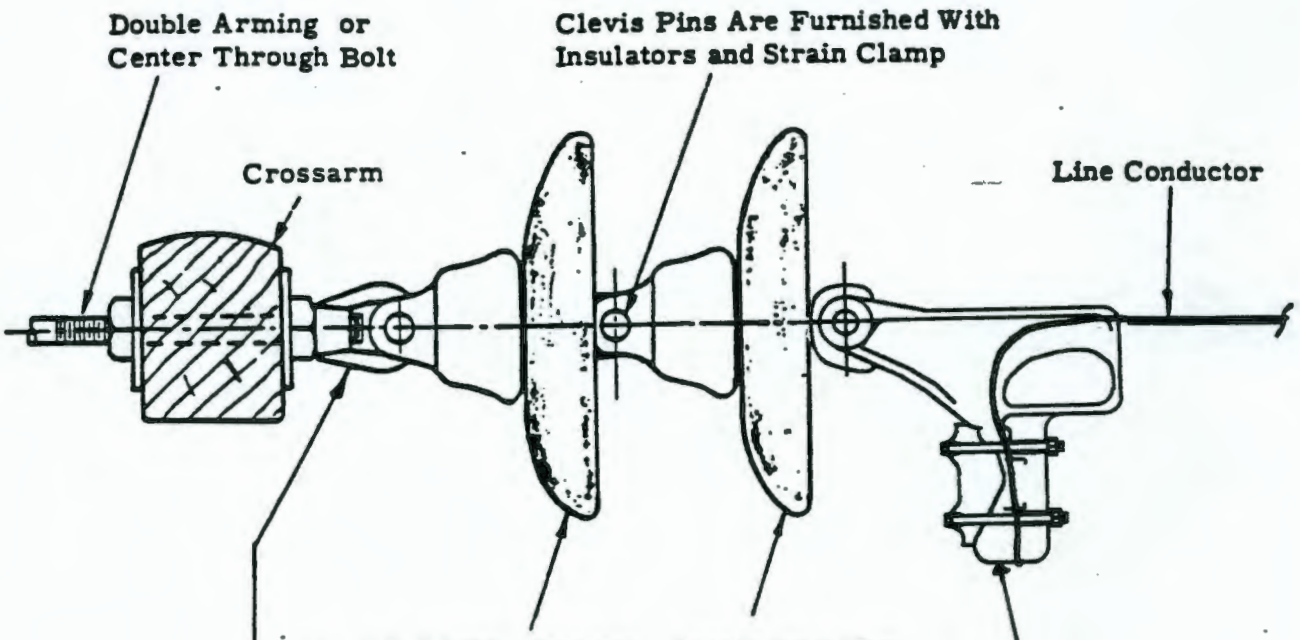

1. CLEVIS TYPE SUSPENSION INSULATOR - 2 REQUIRED
   ANSI C29.2, Class 52-4
   For 13.8 KV Distribution

2. STRAIN CLAMP - ALUMINUM ALLOY
   RELIABLE NUMBER DA-15H-N, DA-2D-N

3. STANDARD EYE NUT - 3/4 INCH
   CHANCE CAT. NO. 6503

- EACH ITEM SHALL BE AS SPECIFIED OR EQUAL.

DEAD-END INSULATOR ASSEMBLY, 13.8 kV
DETAIL 2

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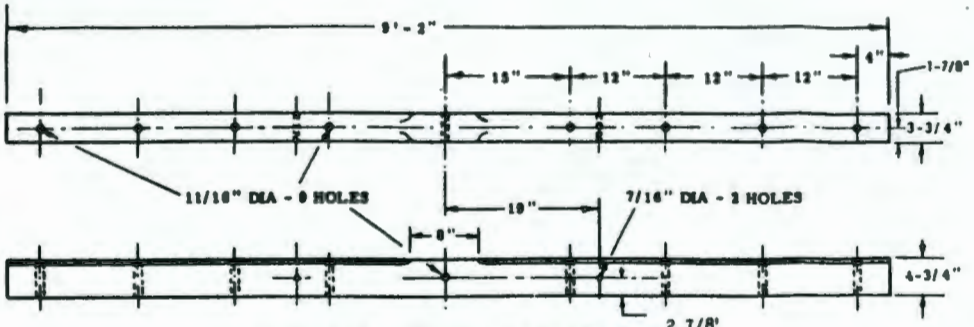
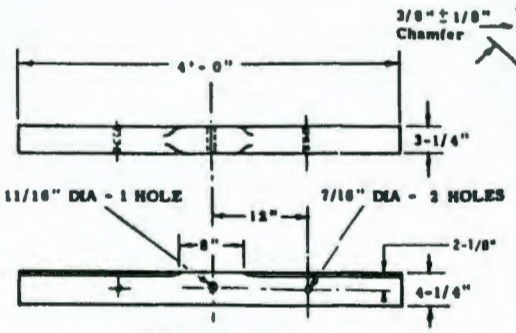
U.S. DEPARTMENT OF ENERGY
Hanford Waste Vitrification Plant
Richland, Washington
DOE Contract DE-AC06-86RL10838

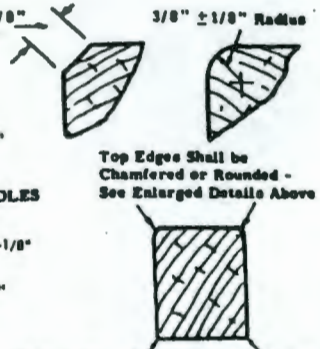
FLUOR DANIEL, INC.
Advanced Technology Division
Fluor Contract 8457
Rev. 0



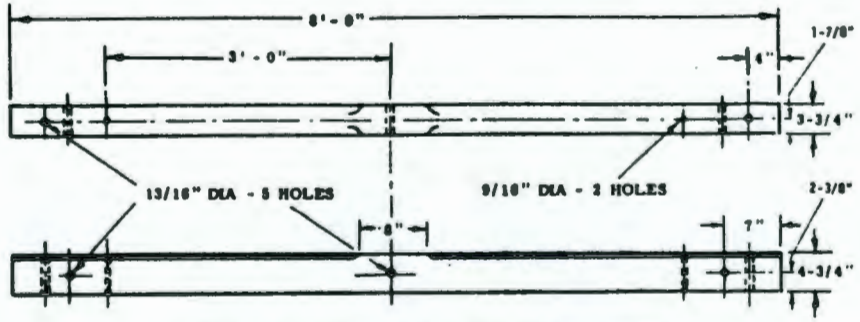
9 FT - 2 IN, 8 PIN ARM FOR 5 kV CONSTRUCTION



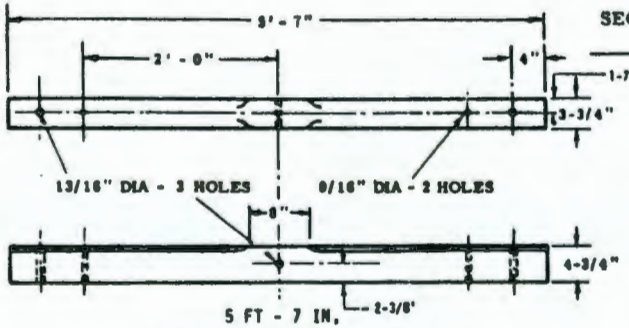
4 FOOT GUARD ARM



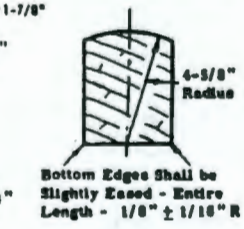
SECTION THRU ARMS -



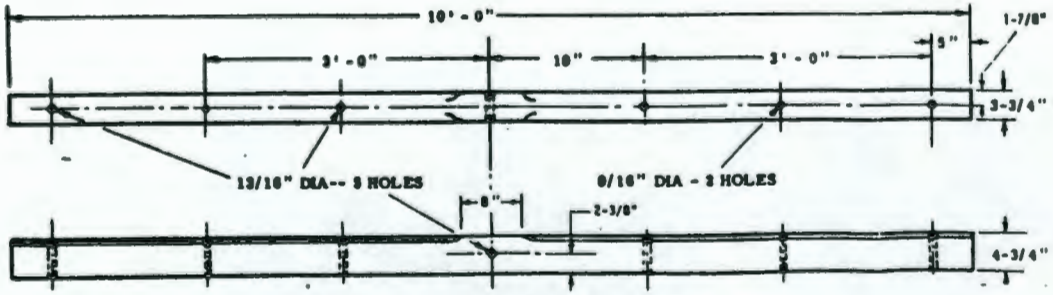
8 FOOT, 2 PIN ARM FOR 13.8 kV DEAD END CONSTRUCTION



5 FT - 7 IN, 2 PIN ARM FOR 13.8 kV CONSTRUCTION



SECTION THRU 'ROOFED' ARMS



10 FOOT, 4 PIN ARM FOR 13.8 kV CONSTRUCTION

NOTES

1. Crossarms shall be in accordance with ANSI O5.3, DOUGLAS FIR, BRIDGE MANUFACTURING CO. OR EQUAL.
2. The identifying letters 'DF' are required.
3. The top center 8 inch dimension shown is for 'roofed' arms. Where arms in accordance with ANSI O5.3 are furnished, the top center 12 INCHES shall not be chamfered or rounded

STANDARD WOOD CROSSARM DETAIL 3

A170-16110

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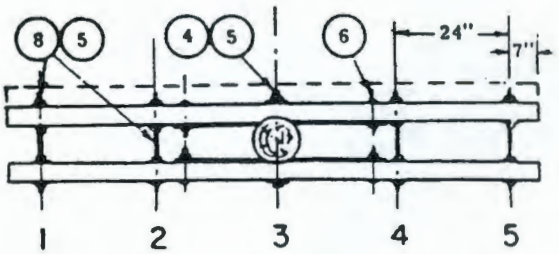
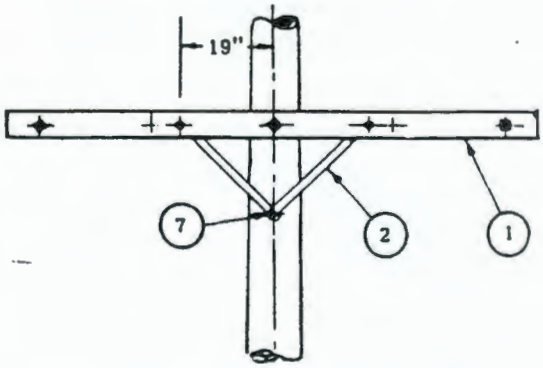
MATERIAL LIST		
Item No.	Qty.	DESCRIPTION
		LIGHT CONSTRUCTION - DETAIL A
1	2ς	Crossarm - 9'-2" SEE DETAIL 3
2	4	Crossarm Brace - Flat 7/32" x 1-7/32" x 28"
4	1	Machine Bolt - 5/8" Dia x Length Required *
5	10$	Washer - 2-1/4" Sq x 3/16" - 11/16" Hole *
6	4	Carriage Bolt - 3/8" x 5" *
7	2	Lag Screw - 1/2" x 5"
8	2ω	Double Arming Bolt - 5/8" Dia x Length Req*
		HEAVY CONSTRUCTION - DETAIL B
1	2ς	Crossarm - 9'-2" SEE DETAIL 3
3	2	Crossarm Brace - 72" Span - See Note 5 *
4	1	Machine Bolt - 5/8" Dia x Length Required *
9	1	Machine Bolt - 3/4" Dia x Length Required *
10	10$	Washer - 3" Sq x 1/4" - 13/16" Hole *
11	4	Machine Bolt - 1/2" Dia x 6" *
12	4	Washer - 1-3/8" Rd x 12 Ga - 9/16" Hole *
13	2ω	Double Arming Bolt - 3/4" Dia x Length Req*

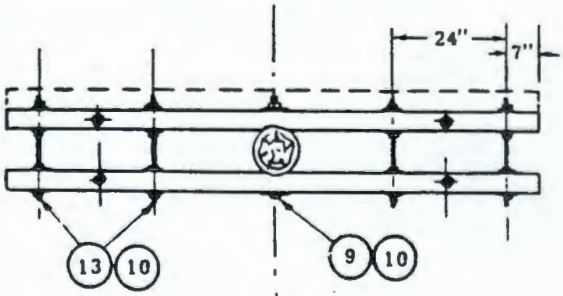
* Hardware shall conform to American National Standard Institute.
ς See Note 4 for use of triple arms for dead-ending.
ω Use additional double arming bolts where conductors are dead-ended at positions 2 or 4.
$ Add four washers for each additional double arming bolt.

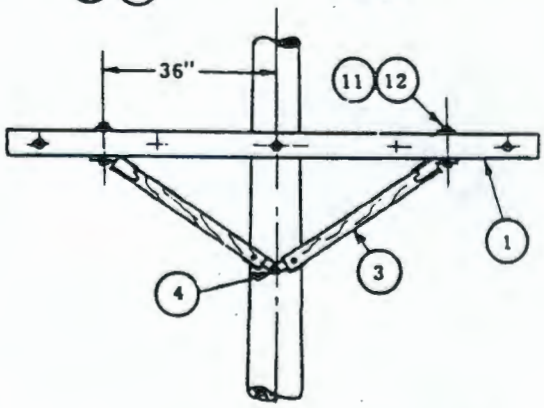


DEAD ENDING POSITIONS
See Note 4



LIGHT CONSTRUCTION - DETAIL A





HEAVY CONSTRUCTION - DETAIL B

NOTES

1. These double crossarm assemblies are for vertical and dead end support of conductors. See other Hanford Elect Stds or the construction drawings for crossarm positions on poles.
2. Use light construction for a single power circuit (three conductors) of No. 1/0 Awg or smaller wire having a span length of not over 150 feet. Incidental street or fence lighting wires, dead ended or on pins, may be included.
3. Use heavy construction (1) for two power circuits (six conductors) on the same arm, (2) for one circuit of conductors larger than No. 1/0 Awg, or (3) where the span length exceeds 150 feet.
4. Use dead end positions as shown below with either light or heavy construction for three-conductor circuits having a span length not exceeding 150 feet on crossarms without arm guys.

DOUBLE ARM		TRIPLE ARM	
Wire Size Awg	Dead End Position	Wire Size Awg	Dead End Position
2 and smaller	1-2-5 1-4-5	1 and smaller	1-2-5 1-4-5
1	1-3-5	1/0 and 2/0	1-3-5
1/0 to 3/0	2-3-4	4/0 to 250 MCM	2-3-4

5. Item 3 Crossarm Brace shall be Douglas Fir treated WITH A FACTORY APPLIED PRESERVATIVE and have galvanized steel end fittings of a type that use a vertical mounting bolt through the crossarm.

DOUBLE CROSSARM ASSEMBLY FOR VERTICAL AND DEAD-END LOADING DETAIL 4

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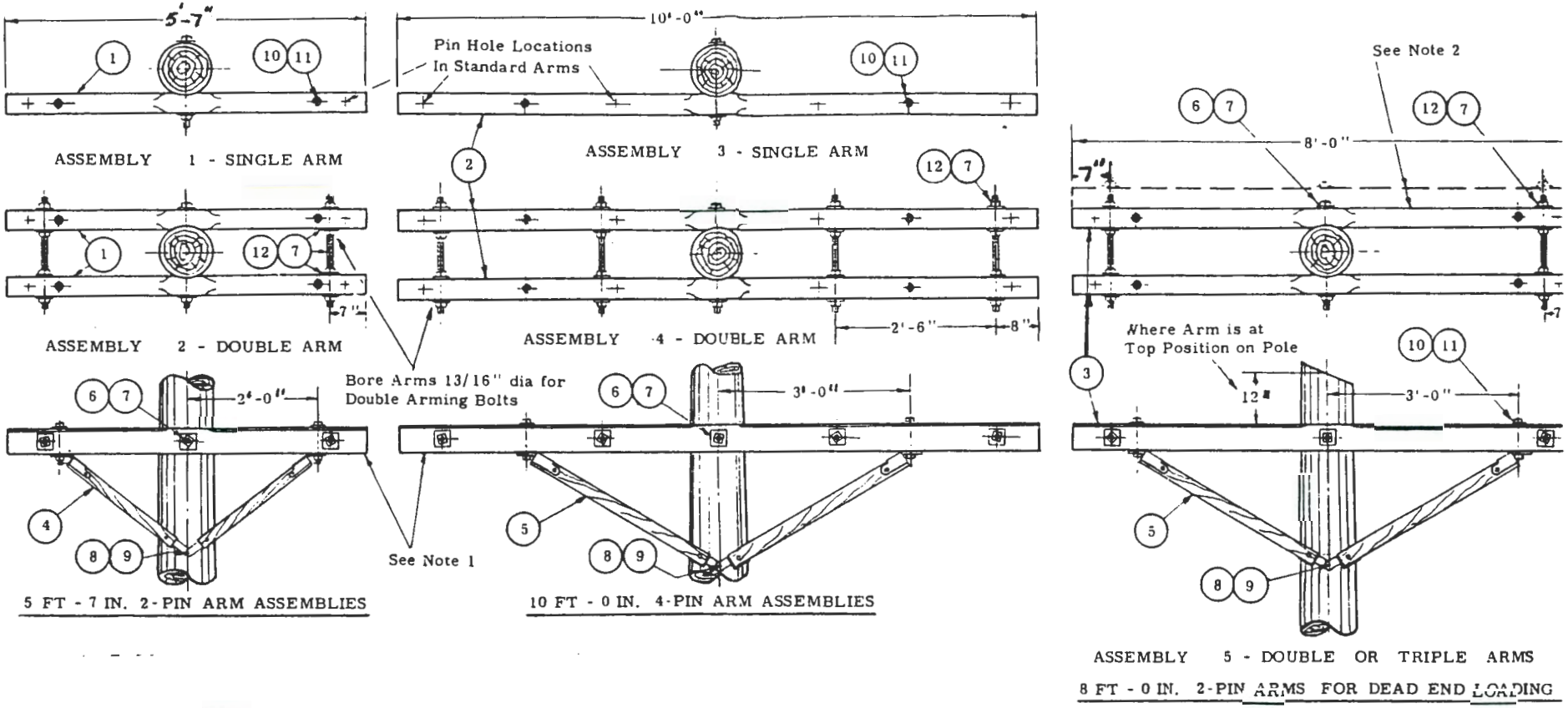

Item No.	ASSEMBLY 1	ASSEMBLY 2	ASSEMBLY 3	ASSEMBLY 4	ASSEMBLY 5	MATERIAL LIST *These items shall conform to American National Standard Institute — DESCRIPTION
	QUANTITY					
1	1	2	-	-	-	Crossarm - 5'-7" SEE DETAIL 3
2	-	-	1	2	-	Crossarm - 10'-0" SEE DETAIL 3
3	-	-	-	-	2or3	Crossarm - 8'-0" SEE DETAIL 3
4	1	2	-	-	-	*Crossarm Brace - 48" Span - See Note 3
5	-	-	1	2	2	*Crossarm Brace - 72" Span - See Note 3
6	1	1	1	1	1	*Machine Bolt - 3/4" x Length Required
7	2	10	2	18	10	*Washer - 3" Square x 1/4" x 13/16" Hole
8	1	1	1	1	1	*Machine Bolt 5.8" x Length Required
9	-	-	1	-	-	*Washer - 2- /4 square x 1/16" x 11/16" Hole
10	2	4	2	4	4	*Machine Bolt - 1/2" x 6"
11	2	4	2	4	4	*Washer - 1 3/8" Round x 12 Gage x 9/16 Hole
12		2	-	4	2	*Double Arming Bolt - 3/4" x Length Required

NOTES
1. Unless otherwise shown on other Standards or the construction drawings, single crossarm assemblies may be used for conductors No. 4/0 Awg and smaller on pin insulators. Double arms shall be used for conductors larger than 4/0 Awg.
2. Use double arms (Assembly 5) for dead ending conductors No. 1 Awg and smaller at arming bolt and center positions. Use triple arms for conductors No. 1/0 Awg and larger.
3. Item 4 and 5, Crossarm Brace shall be Douglas fir treated with A FACTORY APPLIED PRESERVATIVE AND SHALL HAVE galvanized steel end fittings of a type that use a vertical mounting bolt through the crossarm.

WOOD CROSSARM ASSEMBLIES FOR 13.8 kV CONSTRUCTION
DETAIL 5

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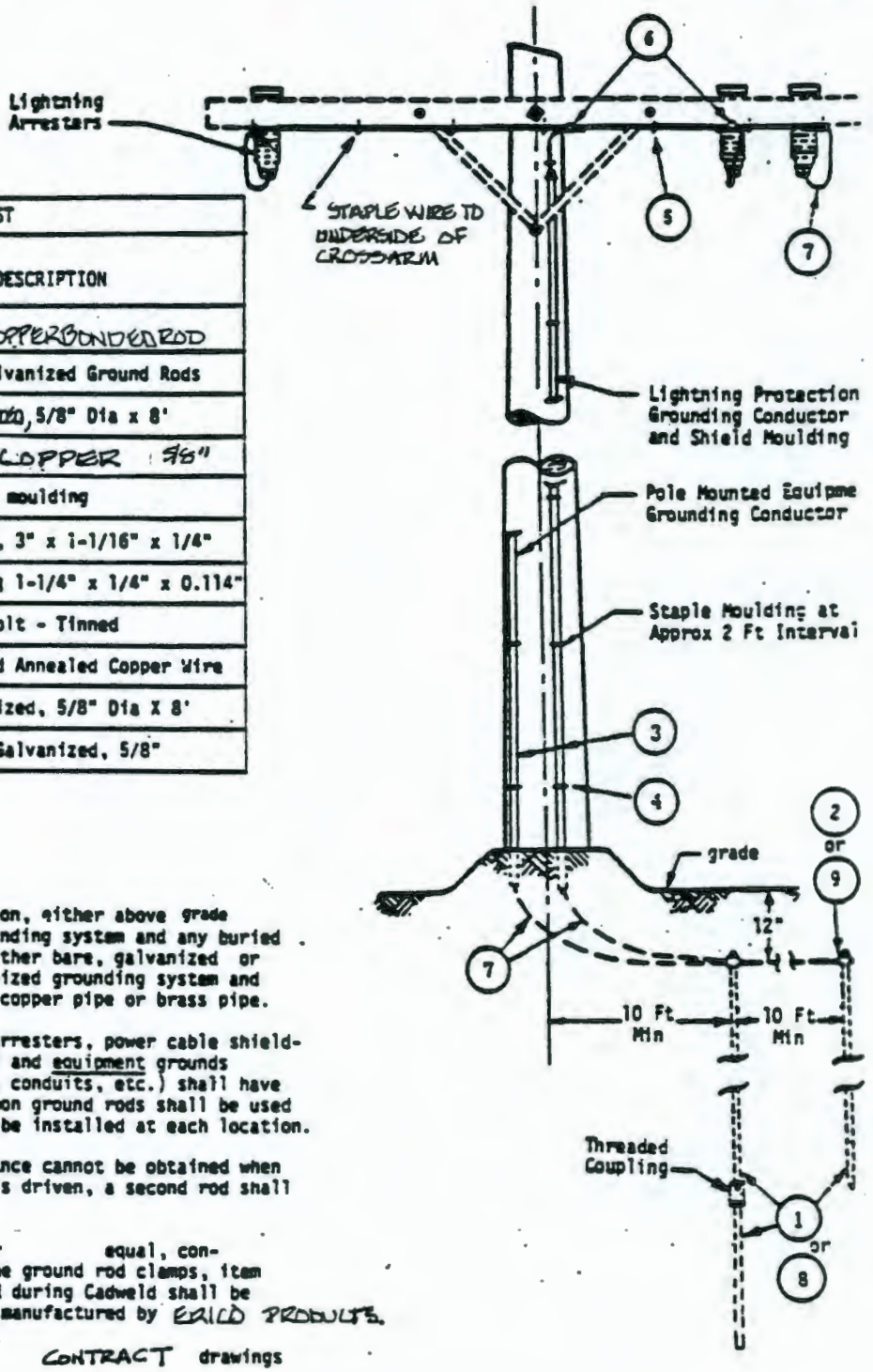
MATERIAL LIST			
Item No	QUANTITY		DESCRIPTION
	X		Grounding Assy w/COPPER BONDED ROD
		X	Grounding Assy w/Galvanized Ground Rods
1	2	—	Ground Rod-COPPER BONDED, 5/8" Dia x 8'
2	2	—	Ground Rod Clamp - COPPER 5/8"
3	Reqd	Reqd	Plastic Ground wire moulding
4	Reqd	Reqd	Staple - Galvanized, 3" x 1-1/16" x 1/4"
5	Reqd		Staple - COPPER COATED 1-1/4" x 1/4" x 0.114"
6	Reqd	Reqd	Connector - Split Bolt - Tinned
7	Reqd	—	No. 4 AWG Bare Solid Annealed Copper Wire
8	—	2	Ground Rod - Galvanized, 5/8" Dia X 8'
9	—	2	Ground Rod Clamp - Galvanized, 5/8"



NOTES

1. There shall be no metallic connection, either above grade or underground, between copper grounding system and any buried iron, steel or stainless steel, whether bare, galvanized or otherwise coated, or between galvanized grounding system and any buried copper grounding grids, copper pipe or brass pipe.

2. Grounds for lightning protection (arresters, power cable shielding, telephone cable sheaths, etc.) and equipment grounds (transformer tanks, equip housings, conduits, etc.) shall have separate conductors on poles. Common ground rods shall be used as shown. At least two rods shall be installed at each location.

3. If a 25 ohms or less drop in resistance cannot be obtained when the first length of grounding rod is driven, a second rod shall be added to reach damp earth.

4. Erico Products, Inc., 'Cadweld', or equal, connections may be used in place of the ground rod clamps, item 2 or 9. Galvanized surface damaged during Cadweld shall be treated with Zinc-Rich compound as manufactured by ERICO PRODUCTS.

5. See CONTRACT drawings for ground connections on poles.

DISTRIBUTION GROUNDING ASSEMBLY WITH APPROVED GROUND RODS
DETAIL 6

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U.S. DEPARTMENT OF ENERGY
Hanford Waste Vitrification Plant
Richland, Washington
DOE Contract DE-AC06-86RL10838

FLUOR DANIEL, INC.
Advanced Technology Division
Fluor Contract 8457
Rev. 0

MATERIAL LIST

45 DEGREE DOWN GUYS — 20,500 LBS. ULTIMATE STRENGTH

ITEM NO	QUANTITY Insulated Guys	QUANTITY Grounded Guys	DESCRIPTION	Alternate Grades of Guy Strand				
			GUY STRAND Grade, Size, and Number of Strands →	Extra H. S. 7/16" - 7	High Strength 9/16" - 7	Utilities 1/2" - 7	Extra H. S. 1/2" - 7	Siemens-Martin 3/4" - 19
1	Length as Required							
2	4	2	* Guy Clamp-Heavy Type, 3-5/8" Bolts, 6" Long					
3	4	2	Serving Sleeve - To Suit Guy Strand Used →					
4△	4	2	△Guy Grip - Preformed Line Products Co., Catalog No.	GDE 1108	BG 2116	BG 2115	BG 2115	
5◇	2	2	Strandvise Reliable Electric Co Catalog No. — Short Bail	5203	NM	5204	5204	3-Wire Rope Clips at Attachments Drop Forged Steel TOP Style
6◇	2	NU	Strandvise Reliable Electric Co Catalog No. — Long Bail	5253	NM	5254	5254	
7	1	NU	Strain Insulator - ANSI C29.4 Class 54-1 →					

HORIZONTAL GUYS — 14,500 LBS ULTIMATE STRENGTH SEE LOADING TABLE

ITEM NO	QUANTITY Insulated Guys	QUANTITY Grounded Guys	Alternate Grades of Guy Strand					
			Length as Required	High Strength 7/16" - 7	Extra H. S. 3/8" - 7	Siemens-Martin 9/16" - 7 or 19	Utilities 7/16" - 7	Siemens-Martin 5/8" - 19
1	Length as Required							
2	6	2	→					
3	6	2	→					
4△	6	2		GDE 1108	GDE 1107	BG 2116	GDE 1108	NM
5◇	2	2		5203	5102	NM	5203	NM
6◇	4	2		5253	5152	NM	5253	NM
7	2	NU						

45 DEGREE DOWN GUYS

ITEM NO	QUANTITY	DESCRIPTION	
8	1	Pole Band - 3/8" x 4" Steel 7-1/2" to 12" Pole Dia	Hughes Bros. No. 3105
9	1	Single Guy Attachment	Hughes Bros. No. 3153
10	1	Guy Roller	
11	1	Plastic Guy Guard - Yellow -	
12	1	Anchor Rod - Double Thimble Eye - 1" x 9'-0"	
13	1	24" CONCRETE CONE ANCHORS (DOUBLE OR TWIN)	

HORIZONTAL GUYS

ITEM NO	SPAN GUY WITH DOWN GUY	SPAN GUY ONLY	DESCRIPTION	
8	1	2	Pole Band	Hughes Bros No. 3105
9	2	2	Single Guy Attachment	Hughes Bros No. 3153
10	1	1	Guy Roller	

EACH ITEM SHALL BE AS SPECIFIED OR AN APPROVED EQUAL.

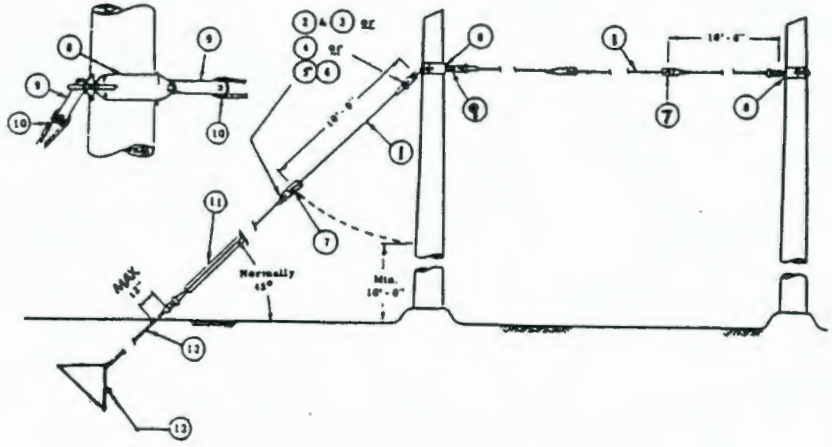
△ Alternate A

◇ Alternate B

* These items shall conform to American National Standard Institute.

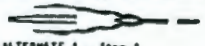
NM Not manufactured for the size of guy strand shown.

NU Not used for the construction indicated.

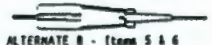


NOTES

1. The Loading Table shows the maximum horizontal line loads for which this Standard may be used. Safety Factors are for Grade B construction. Allowance has been made in the Bill of Material for the increased tension in the strand and hardware for 45 degree down guys.
2. High Strength grade of guy strand shall be used for telephone and 230 KV line guying, and Siemens-Martin grade shall be used for all other electrical distribution guys unless otherwise specified or the use of a substitute grade is specifically approved.
3. Where horizontal guys are installed with down guys, the horizontal guy may be the same size strand as that required for the down guy.
4. The use of 3-bolt clamp, strandvise, or guy grip hardware is optional at any position in the guy assembly.
5. This Standard assembly is designed for telephone and electrical distribution pole guying and should not be applied indiscriminately to other structures.



ALTERNATE A - Item 4
Preformed Guy Grip



ALTERNATE B - Items 5 & 6
Strandvise -
Short Bail for Thimble Eye Hardware
Long Bail for Insulators

ALTERNATE GUY HARDWARE

LOADING TABLE		
Type of Guy	Safety Factor	Maximum Horizontal Line Load - Pounds
Dead Ends	1.5	9700
Longitudinal - General	1.0	14500
Transverse	2.66	5400

EXTRA-HEAVY DUTY GUYS - ULTIMATE HORIZONTAL LOAD OF 14,500 LBS MAXIMUM

EXTRA HEAVY DUTY HORIZONTAL AND DOWN GUY ASSEMBLIES
DETAIL 7

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SECTION 16905
ELECTRICAL TESTING

PART 1 GENERAL

1.1 SUMMARY

1.1.1 This specification section sets forth the electrical field testing procedures required for the acceptance of electrical materials, equipment, components and/or systems for construction power, as shown on the Contract Drawings and specifications.

1.1.2 The purpose of the specified tests and inspections is to determine that each component is in compliance with the Contract Drawings and specifications and in satisfactory condition to successfully perform its intended function.

1.1.3 It is the intent of these procedures to ensure that all workmanship, materials and the manner and method of erection and installation conform to manufacturer's instructions, the Contract Drawings and specifications.

1.2 REFERENCES

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 400	1980 Making High-Direct-Voltage Tests on Power Cable Systems in the Field, Guide for

MILITARY STANDARD

MIL-STD-45662A	1988 Calibration Systems Requirements

1.3 RELATED REQUIREMENTS

Specification Section 16100	Electrical Installation
Specification Section 16110	Electrical Materials and Devices

1.4 **SUBMITTALS**

Submit the following in accordance with the Vendor Drawing and Data Requirements section of the Order/Subcontract.

1.4.1 Written procedures for all inspection and testing to be performed.

1.4.2 Inspection reports for underground cable installation.

1.4.3 Inspection reports for lighting systems.

1.4.4 Test and inspection reports for power cables.

1.4.5 Test and inspection reports for grounding system including ground rods.

1.4.6 Test and inspection reports for 13.8 kV switchgear.

1.4.7 Test and inspection reports for 13,800-480/277V transformers.

1.4.8 Test and inspection reports for 480/277V switchboards.

1.4.9 Test and inspection reports for 13.8 kV and 2.4 kV overhead distribution lines.

1.4.10 Test and inspection reports for 480-208/120V transformers.

1.4.11 Calibration and Testing Equipment Standards

The Seller shall submit to the Buyer for approval, a complete listing of proposed calibrating and testing equipment, including calibration standards with current certification from Military Standard MIL-STD-45662A.

1.5 **PROJECT OR SITE ENVIRONMENTAL CONDITIONS**

1.5.1 Climatic and Geographic Site Conditions

A. Site Elevation 714 feet above sea level

B. Barometric Pressure 14.3 psia

C. Outside Design Temperature

(1) Maximum Design Temperature 110°F

(2) Minimum Design Temperature -20°F

1.5.2 Operating Environment

A. Normal Temperature -20° to 110°F

PART 2 PRODUCTS

2.1 MATERIALS AND/OR EQUIPMENT

2.1.1 Furnish all materials and equipment required to perform inspection and testing in accordance with this specification.

2.1.2 All equipment used for testing shall be calibrated within six months prior to testing, and Seller shall provide proof of calibration.

2.1.3 All calibrating and testing equipment must be checked every six months, except idle equipment which must be calibrated prior to usage, to the standards for the project, and certified as being accurate. Certified shall mean affixing a label stating that the equipment has been checked against the standard for the project, for accuracy, dated and initialed by the certifier and date of next required calibration. Project standards shall be traceable to the National Institute of Standards and Technology.

2.1.4 Any equipment failing the standards test must not be used until repaired and re-standardized. All calibrating and testing equipment shall have valid certified label affixed to the equipment during usage. The label shall be affixed in a prominent location. Standards must not be used as testing devices in the field.

2.1.5 The Seller shall be required, every six months, to check the standards for the project to calibration standards traceable to the National Institute of Standards and Technology.

2.1.6 Ensure that the accuracy of the testing equipment is equal to (or better than) the accuracy of the equipment to be calibrated/ tested.

2.1.7 Maintain a calibration log showing date (calibrated and next calibration), location, name of lab (if applicable), certification number and name of certifier. Log must be kept current and available to the Buyer for inspection.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Submit all test procedures to Buyer for approval prior to testing.

3.1.2 All test voltages listed in this specification shall be checked against manufacturer's instructions and adjusted as applicable.

3.2 **FIELD QUALITY CONTROL**

3.2.1 General

3.2.1.1 All wiring and connections shall be tested for continuity before fixtures, devices and equipment are connected.

3.2.1.2 Overhead distribution system shall be inspected to verify that they are installed in accordance with Contract Drawings, specifications, manufacturer's recommendations and National Electrical Safety Code.

3.2.2 Power Cable Tests

3.2.2.1 Continuity Test

A. Test for continuity, correctness of wiring and verify correct identification on all insulated conductors installed and test for continuity and correctness of wiring on all ACSR conductors installed.

B. Test shall be made with an ohmmeter.

3.2.2.2 Insulation Resistance Test

A. All insulated conductors shall be given an "Insulation Resistance Test" using a Megohmmeter.

B. Test shall be made with the conductors disconnected at the equipment. Test shall be made between one conductor and ground with the other conductors grounded. Each conductor shall be tested in the same manner. The voltage shall be applied and readings taken every minute until three equal and consecutive readings are obtained.

C. Disconnected wires shall be safety tagged. Disconnect devices (circuit breakers, switches, etc.) will be safety tagged and locked open.

D. Test voltages and minimum acceptable insulation resistance shall be as follows:

Insulation Voltage	Test Voltage	Min. Insulation Resistance
600 volt ac	1000 Vdc	10 megohms

3.2.2.3 DC High Potential Tests

3.2.2.3.1 The cable high voltage tests shall be performed on all 5 and 15 kV cables in accordance with IEEE 400.

3.2.2.3.2 Cables shall not be connected to equipment.

3.2.2.3.3 Testing on 5 kV cable shall be at 21 kVDC for a duration of fifteen minutes.

3.2.2.3.4 Testing on 15 kV shielded cable shall be at 55 kVDC for a duration of fifteen minutes.

3.2.2.3.5 In addition to recording the test results, a time/current plot of each test shall be completed.

3.2.2.3.6 High potential tests shall not be repeated without authorization by the Buyer.

3.2.3 Grounding System

3.2.3.1 All ground connections shall be inspected for tightness and to assure connections have been completed as shown on the Contract Drawings.

3.2.3.2 Relays for ground protection and system neutrals shall be tested and calibrated.

3.2.3.3 The earth resistance of each ground electrode shall be measured and recorded before electrodes are connected to the grounding loop. Electrodes in each ground loop shall be sufficient to give a ground loop earth resistance less than one ohm. Ground loop electrode tests may be suspended upon achieving required loop resistance.

3.2.3.4 Earth resistance measurements shall be made by using "Megger" ground-tester in accordance with manufacturer's instructions.

3.2.3.5 The continuity of underground ground loop conductors shall be verified with an ohm meter before making connections. Resistance to ground shall be measured with a 500 volt megger, minimum resistance shall be 1.0 megohm.

3.2.3.6 Equipment ground buses in electrical equipment, such as switchboards, shall be tested to assure low resistance bolted connection between bus and equipment enclosure. Resistance testing using a "Kelvin Bridge" shall be taken between the equipment ground bus and the equipment enclosure. The maximum acceptable resistance shall be 0.01 ohms.

3.2.4 13.8 kV Switchgear

3.2.4.1 All equipment shall be inspected for damage to insulators and other components, after shipping and setting. All equipment electrical and mechanical connections including meter terminals shall be checked in accordance with manufacturer's instructions.

3.2.4.2 All removable elements shall be checked for proper alignment and ease of insertion and withdrawal in accordance with manufacturer's instructions.

3.2.4.3 All moving elements shall be inspected for removal of all shipping blocks and for proper mobility. Inspect to ensure all arc chutes, phase barriers, protective covers and shields are installed properly before energizing equipment. All installation debris shall be removed prior to energization.

3.2.4.4 Check to ensure all fuses, primary and secondary, are of proper size and rating.

3.2.4.5 Prior to energizing, insulation resistance of each bus shall be measured from phase-to-phase and from phase-to-ground with air interrupter switches open.

Values of insulation resistance less than manufacturer's recommendation minimum are not acceptable. The following values shall be acceptable as a minimum:

Equipment Voltage Class	Resistance (Megohms)	Test Voltage
13800 V	16	5000 V dc

3.2.4.6 Prior to energizing, insulation resistance of control circuits shall be measured to ground.

3.2.4.7 Before energizing, all air interrupter switches shall be subjected to the following tests:

3.2.4.7.1 Check switch alignment, wipe and, if necessary, adjust in accordance with the manufacturer's instructions.

3.2.4.7.2 With switch closed, use a low resistance ohm meter to measure and record the resistance of the switch contacts. Values shall correspond to manufacturer's standards.

3.2.4.8 Ratios of all current transformers and voltage of all potential transformers shall be checked against specifications. The secondary circuits of all current transformers shall be checked

for continuity with current transformer connections disconnected. Ground test of secondary circuit shall confirm ground connection is made, only at one terminal of current transformer. Use ohm-meter set on the one ohm scale for above tests. Remove or open current transformer shorting bars before energizing.

3.2.4.9 Instrument transformer secondary circuits shall be tested by the following methods:

3.2.4.9.1 Apply current to the secondary circuits of current transformers and verify that proper meters operate.

3.2.4.9.2 Apply voltage to the secondary circuits of potential transformers and verify that meters operate properly.

3.2.5 13,800-480/277V Transformers

3.2.5.1 In setting up the testing equipment, special safety precautions should be taken regarding grounding of this equipment and the transformer to be tested. The test equipment and the transformer shall be grounded to the same ground.

3.2.5.2 Primary/secondary cables shall be inspected for mechanical damage. Bolted connections shall also be inspected for proper torque in accordance with manufacturer's recommendations.

3.2.5.3 Transformer nameplate shall be checked against the purchase specification.

3.2.5.4 Test insulation resistance of transformer windings prior to energization. Test primary insulation to ground with enclosure and secondary winding grounded, use 500 Vdc for equipment rated 480V and use 5000 Vdc for equipment rated 13.8 kV. The voltage shall be applied for one minute and until the reading reaches a constant value. Test the secondary winding to ground with the primary winding grounded. Similarly test the primary winding to the secondary winding. The minimum acceptable insulation resistance in megohms is eight times the kV rating of the winding under test.

3.2.5.5 Measure primary and secondary voltage with tap changer in each position and verify that voltage ratio are per transformer name-plate. Apply construction power to primary transformer connection and measure secondary voltages. Primary voltage rating shall not be exceeded.

3.2.6 480/277V Switchboard

3.2.6.1 All equipment shall be inspected for damage to insulators and other components, after shipping and setting. All equipment electrical and mechanical connections including relay terminals shall be checked in accordance with manufacturer's instructions.

3.2.6.2 All removable elements shall be checked for proper alignment and ease of insertion and withdrawal in accordance with manufacturer's instructions. All mechanical interlocks shall be checked for proper operation.

3.2.6.3 All moving elements shall be inspected for removal of all shipping blocks and for proper mobility. Inspect to ensure all arc chutes, phase barriers, protective covers and shields are installed properly before energizing equipment. All installation debris shall be removed prior to energization.

3.2.6.4 Before energizing the equipment, the insulation resistance of each bus shall be measured from phase-to-phase and from phase-to-ground with disconnect devices open.

Values of insulation resistance less than manufacturer's recommendation minimum are not acceptable. The following values shall be acceptable as a minimum:

Equipment Voltage Class	Resistance (Megohms)	Test Voltage
480 V	1.6	500 V dc

3.2.6.5 Check all circuit breakers for correct mechanical and electrical operation.

3.2.7 13.8 kV Fused Interrupter Switches.

3.2.7.1 All equipment shall be inspected for damage to insulation.

3.2.7.2 All moving elements shall be inspected for removal of all shipping blocks and for proper mobility before energizing equipment.

3.2.7.3 All fuses shall be checked to ensure of proper size and rating.

3.2.7.4 Before energizing, fused interrupter switches shall be subjected to the following tests:

3.2.7.4.1 Check switch alignment and wipe and, if necessary, adjust in accordance with the manufacturer's instructions.

3.2.7.4.2 With switch closed, use a low resistance ohm meter to measure and record the resistance of the switch contacts. Values shall correspond to manufacturer's standards.

3.2.7.4.3 Switch shall be operated by using vertical reciprocating mechanisms for proper operation in accordance with manufacturer's instructions.

3.2.8 Operation Tests

Upon completion of work, all electrical materials and equipment shall be operated under working loads to demonstrate conformance with the requirements herein.

3.2.9 480-208/120V Dry-Type Transformer

In setting up the testing equipment, special safety precautions should be taken regarding grounding of this equipment and the transformer to be tested. The test equipment and the transformer shall be grounded to the same ground.

3.2.9.1 Test reports shall include the following:

A. Complete identification of the transformer.

B. Megger readings.

3.2.9.2 Transformers shall be dried out in accordance with manufacturer's instructions before they are energized if insulation resistance measurements indicate the presence of moisture.

3.2.9.3 Mechanical

Transformers shall be checked for tightness of external structural members and mechanical joints in order to minimize audible sound levels. All ground connections shall also be checked.

3.2.9.4 Insulation Resistance

3.2.9.4.1 Transformers shall be given an "Insulation Resistance Test" using a megohmmeter.

3.2.9.4.2 The voltage shall be applied between: Each winding and ground, each winding to winding. Test voltages and minimum acceptable resistance readings are as follows:

Equipment	Test Voltage	Minimum Reading
480 volt winding	1000	2 megohms
120/208 volt winding	1000	2 megohms

3.2.9.4.3 Minimum resistance readings shall be as listed above unless recommended otherwise by transformer manufacturer.

3.2.9.4.4 The voltage shall be applied for a minimum of one minute until the resistance reading reaches a constant value.

3.3 **CLEANING**

Clean and remove all debris and equipment from the job site after completion of testing.

END OF SECTION