National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

SPECIFICATION NUMBER M5061

CONSTRUCTION SPECIFICATIONS

FOR

REVITALIZE CENTRAL CHILLED WATER FACILITY - ELECTRICAL

BUILDING 4473

GEORGE C. MARSHALL SPACE FLIGHT CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MARSHALL SPACE FLIGHT CENTER, AL

Approval: _____ **Date:** 7/20/15
Lead, Facilities Engineering Office

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SECTION 01 00 10 — SCOPE AND DESCRIPTION

PART 1 - GENERAL

1.1 SCOPE

A. The work to be performed under this project consists of providing the labor, equipment, and materials to revitalize the existing electrical power supply system for the Central Chilled Water Facility (Building 4473). Presently, the power supply to the building is provided by two 12.47KV overhead lines, through a pad mounted 12.47KV automatic transfer switch (PST-9) and two pad mounted 12.47KV junction boxes (PJ-1 and PJ-2). This will be replaced by six 12.47KV underground feeders fed directly from a new 46KV outdoor substation (Unit Substation 23). The new outdoor substation will be located at the North side of Building 4475. The work shall include the following:

B. Supply and installation of a new 46KV outdoor substation (Unit Sub 23) with essentially two 7.5/9.4MVA (55/65C), OA/FA, 46KV delta primary – 12.47KV Grounded Wye, 7.2KV secondary transformers, three 46KV load break switches, two 46KV primary fault interrupter switches, two sets of three (total of 6) 12.47KV voltage regulators, two 12.47KV transformer secondary breakers, one 12.47KV bus tie breaker, six 12.47KV feeder breakers, six 12.47KV load break disconnect switches, 12.47KV main bus and alternate buses.

C. Removal of existing pad mounted 12.47KV automatic transfer switch (PST-9) and existing 12.47KV pad mounted junction boxes (PJ-1 and PJ-2). Removal of their associated 12.47KV input and output feeder cables.

D. Replacement of existing four (4) – 2500KVA, 3Phase, 12.47KV primary – 4.16KV secondary pad mounted facility transformers with two (2) – 7500KVA, 12.47KV primary – 4.16KV secondary pad mounted facility transformers.

E. Removal of existing 4.16KV input power supply to the existing 1000KVA pad mounted building transformer.

F. Conversion of the existing 480Y/277V single ended switchboard to a double ended switchboard. This shall include supply and installation of the tie breaker and second input breaker.

G. Installation of second feeder from the existing building pad mounted building transformer to the converted double ended switchboard.

H. Supply and installation of six 12.47KV underground feeders from the outdoor substation Unit Sub 23 to six pad mounted building transformers.

I. Additive Alternate: Replacement of the existing secondary feeder conductors for the existing two 2000KVA, 12.47KV primary- 480Y/277V secondary pad mounted transformers from the transformer to the existing switchboard.

1.2 DESCRIPTION

A. The work consists of all site preparation, grading, and installation of above ground and underground equipment and structures. This work includes a perimeter grounded fence, gravel bed, grounding system, meter building, and interception of the existing 46KV line connecting Unit Sub 3 and Unit Sub 13. It will include installation of new poles, guy wires, and associated hardware.

1.3 APPLICABLE DOCUMENTS

A. The publications of the issues of referenced documents in effect on the date of issuance of invitation for bids form a part of this specification and, where referred to herein by basic designation only, are applicable to the extent indicated by the references thereto. In the event of difference between this specification or its accompanying drawings and the referenced document, this specification and its accompanying drawings shall govern to the extent of such difference.

1.4 CONTRACT DRAWINGS

A. The following drawings accompany this specification and are a part thereof. The Contractor shall check all drawings and specifications for construction interferences, detail descriptions errors, dimensional errors, and other conflicts and shall promptly notify the Contracting Officer of any discrepancies utilizing a “Request for Information.” The Contracting Officer shall make a written interpretation.

B. The drawings and the specification is based on the following substation equipment:

1. 46KV Load Break Switch: SEECO, Charlotte, NC. Type MNM-1
2. 46KV Fault Interrupter Switch: Southern State LLC, Hampton, GA. Type CM-4
3. Substation Transformer: Virginia Transformer, Roanoke, VA
4. Voltage Regulator: Howard Industries, Laurel, MS
5. 15KV Circuit Breaker: Siemens, Type SDV7-SE with VS-2508 interrupter.
6. Approved equal products of other reputed manufacturers will also be acceptable, if they meet the drawing and specification requirement. Any modification of the installation requirements as shown on the drawings to accommodation of equal products must be approved prior to installation.

C. The following drawings accompany this specification and are a part thereof.

Drawing No.	Title	Revision No.
X1	Index Sheet	0
	Civil	
C1	Unit Substation 23, Existing Conditions, Demolition and Notes.	0
C2	Electrical Substation Layout Plan	0

Drawing No.	Title	Revision No.
C3	Electrical Substation Grading Plan	0
C4	Site Details	0
C5	Chain Link Fence Details	0
	Structural	
S1	Structural – Details for Transformer Pad	0
	Electrical	
E1	General Notes, Symbol List and Abbreviations.	0
E2	Existing One Line Diagram	0
E3	Unit Substation 23 – One Line Diagram	0
E4	Building 4473 Main Power Supply – One Line Diagram	0
E5	Electrical Site Plan	0
E6	Unit Substation 23 Equipment Layout Plan	0
E7	Unit Substation 23 Grounding Plan	0
E8	Unit Substation 23 Lighting Plan	0
E9	Unit Substation 23 Control House	0
E10	Unit Substation 23 Elevations for 46KV Structure	0
E11	Unit Substation 23 Elevations for 12.46KV Structures	0
E12	Unit Substation 23 Elevations for 12.46KV Structures	0
E13	Unit Substation 23 Duct Bank Plan and Details	0
E14	Unit Substation 23 Duct Bank Elevation and Fence Grounding.	0
E15	Unit Substation 23 Pole Details	0
E16	Duct Bank Configuration	0
E17	Conduit Schedule	0
	UCS	
UCS1	UCS Notes and Building 4473 Floor Plan	0
UCS2	Building 4473 Floor Plan	0
UCS3	UCS Demo Wiring Detail & Demo Comm Trunk Layout.	0
UCS4	UCS New Comm Trunk Layout with Fiber Optic Detail	0

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 00 10

SECTION 01 05 90 — SPECIAL CONDITIONS

PART 1 - GENERAL

1.1 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "Submittal Procedures," in sufficient detail to show full compliance with the specification.

A. List of Government-furnished property or equipment identifying the condition of and quantities as received.

B. Photographs of temporary structures to be brought on Center by the Contractor.

1.2 CONTRACTOR'S WORKING DRAWINGS

A. It shall be the Contractor's responsibility to develop all necessary working drawings for the installation of piping, ductwork, conduit, fixtures, and equipment. Design drawings are not intended to eliminate all dimensional conflicts in routing or location of piping, ductwork, conduit, fixtures, equipment, etc. but shall show only the general arrangement. Use of design drawings for working drawings will be at the Contractor's risk, and changes required in installed work due to failure of Contractor to develop working drawings shall be accomplished at no additional cost to the Government. Prefabricated items shall have working dimensions to accommodate the actual field dimension of earlier-installed items. The Contractor shall carefully investigate all structural, mechanical, electrical, architectural, and finish conditions affecting all his work and shall coordinate and resolve all dimensional conflicts.

1.3 COOPERATION WITH OTHERS

A. During the life of this contract it is anticipated that other contractors will be performing operations in the general area where work under this contract is being performed. The Contractor shall cooperate in all respects wherever necessary for the better prosecution of the work.

1.4 EXPLOSIVE AND DISPOSAL AREA PRECAUTION

A. The possibility exists that materials of unexploded ordnance (UXO) could be encountered on NASA/MSFC property. In most areas, the potential for these occurrences is small. However, if materials resembling and suspected to be UXO are discovered in a work area immediately stop all work, cordon off or barricade suspect area, withdraw from the area, contact the Fire Department at 911 and the Facilities Maintenance Organization (FMO) Contracting Officer Representative (COR) and inform them of the findings. Then, post temporary barriers to prevent personnel entry into the area and remain near the site at a safe distance from the suspected UXO until the COR

takes charge of this activity. The COR will then arrange for investigation and safe disposal of suspect material. Upon clearance from the COR, work may then be resumed in the area.

B. Some areas are known to have formerly been utilized for ordnance related manufacturing, delivery, storage, and/or disposal activities. These areas are identified on the “Army and NASA Site Access Control Boundaries” map. When work is to be accomplished in the areas designated on the map as “Facilities Precautionary UXO Area” or as “UXO/CWM Probability ‘Occasional’, ‘Remote’, or ‘Seldom’”, prior to beginning construction, contractor shall procure the services of a UXO services provider (qualified for the project-specific requirements as shown on the drawings) for initial investigation and characterization, and then a remediation recommendation, required when suspect material is detected. Upon receipt of a report that states potential UXO was detected during investigation, the COR will then arrange for disposition of suspect material. UXO services provider shall employ personnel with skills that meet applicable minimum qualification requirements contained in the U.S. Army Corps of Engineers document, “Attachment to Chapter 20, EP 1110-1-18, Ordnance and Explosives Response, UXO Personnel Training and Experience Hierarchy”, at the end of this Section. UXO services provider shall submit for approval documentation that includes the number and names of employees to be utilized for the effort and their corresponding levels of training and experience, including copies of certifications and/or other qualifying paperwork. Additionally, UXO services provider shall have a work plan and a safety plan approved by NASA MSFC prior to initiating job activities. Alternately, when working under a prime contractor, UXO investigation work and safety plan requirements may be included in the prime contractor’s work and safety plans. Questions concerning UXO operations and work plans may be addressed to the COR. Prior to commencing UXO investigation that requires disturbing the soil, obtain a digging permit from the COR.

C. The Contractor shall be responsible for alerting personnel under his authority, including subcontractor personnel, when the site of work is located on a site known to have had former ordnance activity.

D. The “Army and NASA Site Access Control Boundaries” map, showing the areas at MSFC which have the potential to contain UXO, is available for reference. Contact the COR to obtain this information.

1.5 CHEMICAL WARFARE MATERIAL PRECAUTION

A. The possibility exists that chemical warfare material (CWM) could be encountered on NASA/MSFC property. In most areas, the potential for these occurrences is small. However, if such materials are suspected in a work area, immediately stop all work, cordon off or barricade suspect area, withdraw from the area, contact the Fire Department at 911 and the FMO COR, and inform them of the findings. Then, remain near the site at a safe distance from the suspected CWM, and post temporary barriers to prevent personnel entry into the area until the COR takes charge of this activity. The COR will then arrange for investigation and safe disposal of suspect material. Upon clearance from the COR, work may then be resumed in the area.

B. Some areas are known to have formerly been utilized for chemical warfare related manufacturing, delivery, storage, and/or disposal activities. These areas are identified

on the “Army and NASA Site Access Control Boundaries” map. When work is to be accomplished in the areas designated on the map as “UXO/CWM Probability ‘Occasional’, ‘Remote’, or ‘Seldom’”, prior to beginning construction, contractor shall procure the services of a CWM services provider (qualified for the project-specific requirements as shown on the drawings) for initial investigation and characterization, and then a remediation recommendation, required when suspect material is detected. Upon receipt of a report that states potential CWM was detected during investigation, the COR will then arrange for disposition of suspect material. CWM services provider shall meet applicable minimum qualification requirements for the work to be performed. CWM services provider shall submit for approval documentation that includes the number and names of employees to be utilized for the effort and their corresponding levels of training and experience, including copies of certifications and/or other qualifying paperwork. Additionally, CWM provider shall have a work plan and a safety plan approved by NASA MSFC prior to initiating job activities. Alternately, when working under a prime contractor, CWM work and safety plan requirements may be included in the prime contractor’s work and safety plans. Questions concerning CWM operations and work plans may be addressed to the COR. Prior to commencing CWM investigation that requires disturbing the soil, obtain a digging permit from the COR.

C. The Contractor shall be responsible for alerting personnel, including subcontractor personnel, when the site of work is located on a site known to have had former CWM activity.

D. The “Army and NASA Site Access Control Boundaries” map, showing the areas at MSFC which have the potential to contain CWM, is available for reference. Contact the COR to obtain this information.

1.6 SECURITY

A. The Contractor shall conform to security procedures as directed by the Contracting Officer. Additional information will be provided at the preconstruction meeting and as changes occur during the contract period. Status of Center access is available by calling (256)544-HELP.

B. Center Entry and Vehicles: Entry security at the Center is critical to effect a safe environment. All personnel, vehicles, equipment, and materials are subject to search, investigation, and authorization at each entry and while on Center. Construction vehicles and trucks delivering large equipment and materials, including concrete trucks, shall enter the Center via Gate 1 or 10 or as directed by the Contracting Officer. Significant entry delays should be expected, particularly at higher security levels, so the Contractor is responsible for keeping himself apprised of security conditions and entry requirements at the Center and notifying his contract personnel of changes in order to prosecute contract work in a timely manner without delay. All vehicles must have proof of valid registration and insurance residing in the vehicle at all times and shall show such proof to security personnel on demand and in order to obtain a vehicle pass.

C. Personnel Identification and Badging: All personnel shall be able to show proof of United States citizenship and have on their person, valid Government-issued picture identification such as a driver’s license. All Contractor personnel, including subcontractor and visitor personnel, shall have and display on their person a badge

issued by Center security at all times. Center security has the right to not issue, confiscate, or change any badge. The Contractor is responsible for assuring each individual working under this contract is immediately badged in the first instance, continually wears and displays a valid badge, has only the necessary access permissions, and returns the badge to Center security upon completion of their work just prior to leaving the Center. All personnel requiring access to the Center by the Contractor shall possess either a visitor's badge or picture badge issued by Center security at Building 4312. All Contractor personnel requiring access to the east or west test areas must receive test area access training provided by MSFC.

D. Any person on Center failing to have in their possession a valid badge or operating a vehicle without a valid pass is ultimately subject to arrest and further legal action.

1.7 SPECIAL CONSIDERATIONS FOR SPECIAL HOURS OF WORK

A. Reference contract Section H attached to Standard Form 1442 – "Solicitation, Offer, and Award" – regarding "Hours of Work" therein. The following are clarifications and additional requirements necessary to perform work at the Marshall Space Flight Center (MSFC).

1. "Duty Hours" shall be considered to be 7:00 a.m. to 5:00 p.m., Monday through Friday, excluding Government holidays. All other times shall be considered "Non-Duty Hours."
2. The Contractor shall only schedule and plan contract performance during "Duty Hours,", unless specific allowances are made elsewhere herein for specific activities that may be required to be performed during "Non-Duty Hours."
3. The Contractor shall make all requests to work during "Non-Duty Hours" by 9 AM of the day before the requested work period begins. The Contracting Officer must approve any work activities during "Non-Duty Hours" prior to the start of work for the period requested." These requests will typically be denied unless justifiable by outages, road crossings, hazardous operations, coordination with Government operations, and/or facility or subsystem need date.
4. All items above as well as all other Special Conditions of Section 01 05 90 shall be factored into the Contractor's scheduling of work to meet the contract's performance period at no additional cost to the Government after contract award.
5. The Contractor may be prohibited from working in the east and west test areas approximately two days per week during hazardous testing operations. The Government typically issues a tentative weekly schedule on the Friday preceding a week which has scheduled testing. The Contractor is responsible for monitoring this schedule, making regular contact with the test point of contact, closely coordinating their specific activities, and adjusting/delaying construction activities to accommodate testing operations without additional cost to the Government after contract award.

1.8 TEMPORARY UTILITIES

A. Contractor shall provide temporary utilities required for construction. Materials may be new or used, shall be adequate for the required usage, shall not create unsafe conditions, and shall not violate applicable codes and standards.

B. Water: All reasonably required amounts of water will be available to the Contractor by the Government from such existing water systems, outlets, and supplies, without cost to the Contractor for the water he consumes. The Contractor shall be responsible for approved disposal of wastewater. The Contractor shall install and maintain at his own expense any necessary supply connections, safety measures, and facilities in a workmanlike manner as approved by the Contracting Officer. All water shall be carefully conserved. Before final acceptance, temporary connections and piping installed by the Contractor shall be removed in a manner satisfactory to the Contracting Officer.

C. Electricity: Electric power will be made available to the Contractor by the Government in the form of single phase 208V/120V or 240V/120V, depending on availability, 60 Hz, 100A service without cost to the Contractor for temporary power purposes. Other electrical service may be provided, if available and accessible to the construction site, upon request by the Contractor and approved by the Contracting Officer. The Contractor shall install and maintain at his own expense any necessary supply connections, safety measures as required by 29 CFR 1926 Subpart K, 1926-402-408 or NEC ANSI/NFPA 70 plus formal interpretations and tentative interim amendments, and facilities in a workmanlike manner as approved by the Contracting Officer. All electricity shall be carefully conserved. When Government-provided temporary power is not available, is not of sufficient capacity, or is not of sufficient power quality, the Contractor is responsible for providing his own temporary power at his own expense. The Contractor is responsible for protecting his own electrical equipment and devices as necessary at his own expense from damage due to electrical events such as lightning, loss of power, power surges and sags, single phasing, and poor power quality.

D. Compressed Air: The Contractor is responsible for providing compressed air as needed at his own expense.

E. Breathing Air: The Contractor is responsible for providing breathing air as needed at his own expense.

F. Telephone Service: Contractor shall provide his own telephone service at his own expense.

G. Sanitary Facilities: Contractor shall provide temporary sanitary facilities in accordance with 29 CFR 1926.51 and shall service, clean, and maintain these facilities and enclosures at least once per week. Temporary facilities shall be removed from the site at the completion of the work. Sanitary facilities in existing facilities are unavailable for Contractor use.

H. Removal of Temporary Utilities: Before final project acceptance, temporary connections and facilities installed by the Contractor shall be removed and all removal locations painted, graded, etc. as necessary to match surrounding conditions in a workmanlike manner and hazard-free condition to the satisfaction of the Contracting Officer.

1.9 TRAFFIC PROVISIONS

A. Maintenance of Traffic: Contractor shall conduct his operations in a manner that will not close any thoroughfare or interfere in any way with traffic on roadways except with written permission of the Contracting Officer. Contractor may move oversized and slow-moving

vehicles to the worksite provided requirements of the highway authority have been met. Work shall be conducted so as to minimize obstruction of traffic, and traffic shall be maintained on at least half of the roadway width at all times. If the entire roadway width requires blocking, the Contractor shall submit a traffic control plan to the Contracting Officer's Technical Representative for approval prior to blocking the roadway. Approval shall be obtained from the Contracting Officer prior to starting any activity that will obstruct traffic in any manner (one half of the roadway or the entire width of the roadway). Contractor shall provide, erect, and maintain, at his own expense, lights, barriers, signals, passageways, detours, etc., that may be required.

B. Rush Hour Restrictions: Contractor shall not interfere with the peak traffic flows preceding and during normal operations without notification to and approval by the Contracting Officer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PROTECTION OF FACILITIES, MATERIAL, AND WORK

A. The Contractor shall at all times protect and preserve all facilities, materials, supplies, and equipment of every description (including property which may be Government-furnished or owned) and all work performed. All reasonable requests of the Contracting Officer to enclose or especially protect such property shall be complied with. If, as determined by the Contracting Officer, material, equipment, supplies and work performed are not adequately protected by the Contractor such property may be protected by the Government and the cost thereof may be charged to the Contractor or deducted from any payments due him.

3.2 PROTECTION OF UNDERGROUND UTILITIES/DIGGING PERMITS

A. Prior to performing any excavation work or any surface penetrations 6 inches or deeper (such as driving stakes more than 6 inches in the ground) on any ground surface, this includes both outside and inside of buildings, structures, tents, or gazebos, etc., the Contractor shall obtain from the Facilities Office a digging permit and the current subsurface utility drawing of the particular area to be worked on. Subsurface excavations include the penetration of ground below slabs on grade or interior building slabs that are in contact with the ground. Requests for dig permits shall be made a minimum of two working days prior to conducting any planned digging or excavation activities. Contractor shall stake out subsurface high voltage cables, communication cables, and pipelines indicated within the scope of the work contemplated. After exposure, the Contractor shall obtain agreement from the Contracting Officer on how much closer to cable or pipe the excavations can be permitted. Contractor shall notify the Contracting Officer, 48 hours prior to the start of excavation work or surface penetration, to enable the Contracting Officer to review measures being taken to prevent hazard to employees and possible damage to subsurface utilities. Where emergency conditions preclude the 48 hours advance notification, the Contractor shall immediately inform the Contracting

Officer. After obtaining clearance from the Contracting Officer, the Contractor shall proceed with excavating work, or other surface penetration work. Contractor, however, shall temporarily halt any machine excavation work or other surface penetration when approaching within 3 feet of the staked-out cable or pipeline until the Contractor has exposed the cable or pipe by hand excavation to fix its location.

B. Trenching machines and augers shall not be used unless approved in advance by the Contracting Officer.

C. Prior to commencing any operations which include digging, excavations, or soil borings, etc. where there is considerable doubt of the location of concealed utilities, the Contractor shall de-energize or turn off all hazardous utilities to the building and surrounding areas.

D. When de-energizing is not possible, a waiver shall be required to allow work to continue. The waiver shall provide rationale detailing how the safety of the workers will be maintained. The waiver shall be approved by the Facilities Management Office project manager and the MSFC Industrial Safety Office.

3.3 LAYOUT OF WORK

A. The Contractor shall lay out his work from the Government-established base lines and bench marks and shall be responsible for all measurements in connection therewith. The Contractor shall furnish, at his own expense, all stakes, templates, equipment, range markers, and labor as may be required in laying out any part of the work from the base lines and bench marks established by the Government. The Contractor will be held responsible for the execution of the work to such lines and grades as may be established or indicated by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through his negligence prior to their authorized removal, they may be replaced by the Contracting Officer at his discretion. The expense of replacement will be deducted from any amount due, or to become due, the Contractor.

3.4 TEMPORARY STRUCTURES AND LAYDOWN AREA

A. All temporary structures and equipment such as construction office trailers, storage trailers, boom trucks, dump trucks, backhoes, etc. are to be in good and fully operable condition, with no broken windows, rusted areas, boarded-up openings, loose insulation, bent doors, paint in poor condition, leaks, exposed wiring, code or safety violations, or other similar defects when brought on site and are to be maintained in good and fully operable condition while they are on site. Contractor shall submit photographs of all trailers, storage units, or other temporary structures and equipment for review and initial approval prior to bringing them on Center. Regardless, trailers and equipment are to be inspected for final approval for lay down by the Government when they are brought on site prior to detaching them from the truck that delivers them so they can be immediately removed if they are found to be in unacceptable condition.

B. At least 7 days prior to arrival, the Contractor shall request the need for and extent of an all-inclusive lay down area for temporary structures, equipment, material, vehicle parking, fencing, fence gates, hazardous material storage, and the like for the duration

of the work. The lay down area shall be marked up in detail on the site plan drawing and submitted for approval by the Government. Once approved, all office trailers shall be installed per the International Building Code, the Alabama Manufactured Housing Commission, and NASA safety requirements, whichever is most stringent. Any type of structure used in whole or part as office space or otherwise occupied on a regular basis shall be tied down. Utility connections shall be installed according to applicable codes/standards and in a neat and acceptable manner.

C. Housekeeping in the structures and about the lay down area shall be very well kept on a daily basis and the grass, weeds, and the like shall be kept below 6 inches in height at all times; all other areas within the construction site boundaries shall be kept below 12 inches in height. Open storage of material both singularly and collectively shall be kept and in a manner continuously acceptable to the Government.

D. Only equipment and material necessary for the work shall be kept on site, and equipment shall not be repaired on site without prior approval from the Government for more than very minor repairs.

E. All structures and equipment requiring certification, licensure, etc. shall be kept current at all times or immediately removed from the Center. Any changes to the lay down area use, arrangement, boundaries, or egress must be pre-approved by the Government.

3.5 NASA MISSION NON-INTERFERENCE

A. The Center conducts special tests and experiments, as well as unique operations that cannot be interrupted. Certain operations such as Space Shuttle flights have predetermined periods of non-interference where the Contractor can plan ahead with little or no impact to the project Schedule. During such flights, a Dig Moratorium will be issued where the Contractor cannot dig more than 6 inches below the surface.

B. Other non-interferences are utility related and require extensive coordination and precise planning and timing.

C. Non-interference periods shall be shown on the project Schedule to the extent they potentially impact the project Schedule.

3.6 INTERRUPTION OF UTILITIES

A. Interruption to utility services, such as (but not limited to) water, sanitary sewer, steam, electricity, communications, air, high-pressure systems, heating, and air conditioning systems, shall occur at such times as permitted by the Contracting Officer so that interruption of such services will not interfere with the operation of the Center. Generally, such outages to utility services shall be scheduled in advance and caused by the Contractor on Saturdays, Sundays, or other nonworking days or periods at no additional cost to the Government. The existing steam distribution system shall not be altered nor service to existing buildings be interrupted without prior written approval of the Contracting Officer. Such interruption to the steam distribution system insofar as is practicable shall be accomplished in the summer season. All interruptions shall be held to the minimum practicable. Interruption to high-pressure systems must be pre-planned

90 days in advance, with date certain and duration certain.

B. Notice of Interruptions: The Contractor shall submit each and every request for each individual utility outage in writing twenty-one (21) calendar days in advance of the actual need date for approval by the Contracting Officer. Each required interruption anticipated by the Contractor shall be indicated on the project Schedule for pre-planning purposes by the Government to support the work; lack of such indication, or lack of date accuracy where the date changes from the previously approved project Schedule may result in delays and any such delay will be at the sole expense of the Contractor.

3.7 LEAKAGE PREVENTION

A. Capping of Piping Systems: All piping installed by the Contractor that is connected to a pressurized piping system, and not connected immediately to equipment, shall be terminated with a properly rated cap, blind flange, or capped valve and not left open-ended when Contractor personnel are not at the jobsite.

B. Construction Surveillance: At such time when new or modified piping systems are activated, the Contractor shall provide adequate personnel to monitor the initial start-up and operation of that system to insure that no damaging leak occurs. A monitor shall be present at each separate site of piping installation or modification at the instant of system activation. These Contractor personnel shall be authorized to immediately deactivate the system and qualified to make emergency repairs in the event of system failures. The Contractor shall notify Contracting Officer's Technical Representative a minimum of 2 days prior to activation.

3.8 GOVERNMENT FURNISHED PROPERTY

A. If there is any Government Furnished Property, the design drawings will indicate the government furnished property to be incorporated or installed in the work or used in its performance. Salvage property to be removed and reused that is in the general work area shall be handled as a Contractor Service and not listed here.

B. Property shall be furnished on the ground at a location within the MSFC boundaries as designated by the Contracting Officer. The Contractor shall be responsible for paying any demurrage or detention charges incurred loading, unloading, and transporting the property to the job site at his own expense.

C. All such property shall be installed or incorporated into the work at the expense of the Contractor, unless otherwise indicated herein.

D. The Contractor in conjunction with an authorized Government representative shall verify the quantity and condition of such Government-furnished property when delivered to him, acknowledge receipt thereof in writing to the Contracting Officer, and in case of damage to or shortage/overage of such property, he shall within 24 hours report in writing such damage or shortage/overage to the Contracting Officer.

E. It is the intention of the Government to furnish all of these items required to complete the work as specified and the various quantities will be adjusted when necessary. These

quantities are not to be considered as indications or warranties that the amounts stated will either be sufficient or insufficient. The Contractor shall be required to furnish any additional quantities required.

3.9 SALVAGE MATERIALS AND EQUIPMENT

A. The Contractor shall maintain adequate property control records for all materials or equipment specified to be salvaged. These records may be in accordance with the Contractor's system of property control, if approved by the Contracting Officer. The Contractor shall be responsible for the adequate storage and protection of all salvaged materials and equipment and shall replace, at no cost to the Government, all salvage materials and equipment broken or damaged during salvage operations as the result of his negligence, or while in his care. Any salvaged materials and equipment that are excess upon the completion of the work shall remain the property of the Government. All such excess material and equipment shall be loaded, transported, and unloaded by the Contractor in a location specified by the Contracting Officer within the boundaries of the Marshall Space Flight Center.

3.10 CONSTRUCTION PROCEDURES

A. The Contractor shall use the following procedures and methods. Only the most current Government approved forms shall be used.

B. Request for Information (RFI) S.O.P. 7321.6: The purpose of this procedure establishes the system for initiating, dispositioning the clarification of technical or quality assurance requirements specified in the contract documents, and engineering direction to the Contractor for no-cost changes to the specifications or drawings.

C. Design Change Requests (DCR's) S.O.P. 7321.1: The purpose of this procedure establishes the system for documenting and approving changes to the contract documents if on-site work must be performed prior to the contract modifications.

D. Construction Deficiency Reports (CDR's) S.O.P. 7321.3: The purpose of this procedure establishes the system for initiating, processing, distributing, and controlling any item, condition, or material which deviates from engineering drawings, specifications, or procedures which require a disposition from NASA Engineering to resolve.

E. Quality Verification System (QVS) S.O.P. 7321.2: The purpose of this procedure is to plan and perform inspections, tests, and reviews to determine compliance with engineering and quality requirements or procedural methods for data gathering. It provides for planning of activities, establishment of hold points, and documentation of the performance and results of the verification.

F. Preparation, Review, Approval & Control of Submittals S.O.P. 7321.8: The purpose of this procedure establishes the system for initiating, approving, and controlling submittal documents.

G. Field Drawing Changes (FDC) S.O.P. 7321.5: The purpose of this procedure is to establish a method of resolving and documenting same-day, no-cost field adjustments

by the COR.

3.11 ELECTRONIC CAPABILITY

A. The Contractor shall have in-house computer capability to perform daily electronic mail, word processing, Internet connectivity, virus protection, and project scheduling.

B. Contractor management and administration personnel shall be competent in the electronic capability and able to create, print, save, and electronically transfer documents, files, and messages.

C. The Contractor's site superintendent shall have an active cell phone in his possession at all times for emergency and Government representative communication.

D. The Contractor shall submit his e-mail address and emergency contact information, including cell phone numbers, home phone numbers, and pager numbers, for all key personnel as well as the business owner.

3.12 COMMUNICATION RADIOS

A. To insure safety to Government personnel on nearby test stands and to prevent dangerous radio interference from damaging space vehicle test programs underway near site, the Contractor shall not use any radio communication on or near site without coordinating same with Contracting Officer. Radio use is also restricted in certain laboratories, operation centers, and communication and computer rooms as directed by signage and the Contracting Officer. All frequencies used must be submitted for approval by the Contracting Officer prior to use.

3.13 HOUSEKEEPING

A. The Contractor shall comply with the requirements of 29 CFR 1926.25 and assure cleanliness of facilities, equipment, and protection against damage before, during, and after installation. Generally, all working and storage areas will be cleaned regularly. The Contractor shall maintain such conditions insofar as good working practices will permit. It is essential to the proper conduct of the work and to the safety of workers and others that good housekeeping be practiced at all times. Equipment shall be kept clean and shall be protected against damage before, during, and after installation. All working and storage areas shall be cleaned regularly and all scrap materials and refuse properly and promptly disposed of. Accumulations of such materials and, in particular, accumulations of flammable crates, packing, plastic coverings, and other scrap materials in working or storage areas will not be tolerated. All areas shall be left neat, clean, and free from obstructions and hazards at the end of each working day or shift.

3.14 WEATHERTIGHT INTEGRITY OF BUILDING DURING CONSTRUCTION PERIOD

A. Contractor shall not remove or penetrate any portion of the roof that he cannot replace with the specified roofing system by the end of the workday or protect by other approved

methods in the event of rain or other inclement weather that might occur during the workday. The connection of the installed specified roofing system to an existing roofing system shall be made watertight at the end of each workday and/or in the event of inclement weather that might occur during the workday. The details for said connection and the manner that the Contractor plans to maintain a watertight roof throughout the entire period of performance shall be submitted for review and approval by the Contracting Officer's Technical Representative; this shall be approved before work can commence. For 24 hours a day, 7 days per week, throughout the period of the contract, the Contractor will be responsible for keeping moisture outside of the building interior.

B. In the event that there is water penetration, the Contractor shall take immediate action to provide all materials, equipment, and labor to capture the moisture, dispose of the moisture, and protect all contents of the building.

C. The Contractor shall make repairs to stop any water penetration in a timely manner. The Contracting Officer reserves the right to stop the work when he determines the Contractor is not executing the work in a responsible manner and is causing any water penetration of the building. Work will resume once the Contractor has shown evidence that he has prepared an adequate plan for the remainder of the work; said plan shall include preventive measures to assure watertight conditions throughout the remainder of the contract.

D. When the Contractor fails to respond in time to prevent damage from occurring, MSFC maintenance personnel will respond to clean up and protect as best possible until Contractor personnel arrive. Costs incurred by the Government and maintenance operations associated with such response shall be deducted from any of the Contractor’s pay requests and the contract value reduced accordingly by the Contracting Officer.

E. When the Contractor fails to adequately protect equipment and materials, the Contractor shall pay all expenses to replace or repair any and all damages and in a manner acceptable to the Contracting Officer. Such payments shall be made within 30 days of invoice date, and proof of such payments shall be submitted to the Contracting Officer within 15 days of payment date.

3.15 CONSTRUCTION SITE DUST AND MUD CONTROL

A. The Contractor is responsible for establishing effective and mandatory controls to prevent dust and mud from leaving the construction site boundary. These controls shall be communicated to all personnel and enforced at all times. All resulting additional environmental controls required shall be in place, functional, and inspected daily.

B. The Contractor is responsible for preventing wind-blown dust from going outside the construction site boundary including civil works during normal business hours and during other hours the Contractor is present on the site.

C. The Contractor is responsible for preventing vehicles from tracking and depositing mud and other similar debris and materials outside the construction site boundary. Any such tracking or depositing on roadways, parking lots, sidewalks, equipment, building walls, and any other man-made surface shall be cleaned up immediately without delays to the satisfaction of the Contracting Officer. Rainfall is not an acceptable method.

D. The Contractor shall provide at his expense all the necessary labor, equipment, and material.

3.16 CONSERVATION

A. All energy consumption and resources shall be conserved to the greatest extent possible by the Contractor. The Contractor is responsible for communicating this requirement to all on-site personnel and for compliance. Energy and resource utilization shall be proactively managed and conservation measures and methods developed and promoted by the Contractor's management and supervision.

B. Temporary lighting shall be divided into switchable areas of relatively small size to promote and achieve energy conservation to the satisfaction of the Government. Lighting shall be off unless absolutely necessary to accomplish the work at hand. Lighting for security purposes only shall be minimized and other non-energy consuming methods employed to the greatest extent.

C. Recyclable materials (e.g. aluminum cans, white paper, cardboard, metals, etc.) shall be diverted from the waste stream and delivered to the appropriate off-site, off-Center recycle center by the Contractor as indicated.

D. All cardboard materials shall be flattened, consolidated, and recycled. Cardboard may be delivered to the Center's cardboard recycling location.

3.17 TRENCHING/EXCAVATIONS

A. Prior to beginning any excavations, this includes both outside and inside of buildings, structures, tents, or gazebos, etc., an excavation permit shall be obtained from the FMO. Trenching machines and augers shall not be used unless approved in advance by the COR and it shall be so annotated on the issued excavation permit. Before starting any earth work, the location of underground utilities shall be carefully verified. Utilities to be left in place shall be protected from damage. Trench excavations over 5 feet in depth shall be shored braced or sloped to the angle of repose of the material. Excavated or other materials shall be shored and retained at least 2 feet from the edge of the excavation to prevent it from falling or sliding back into the excavated area and to prevent excessive pressure upon the side of the excavation.

B. Excavations, trenching and shoring requirements for the protection of employees in OSHA Regulation, CFR 29 part 1926.650 shall be employed and enforced. Side and slopes of excavations shall be maintained in a safe condition by scaling, benching or barricading. Where employees are required to be in trenches, a ladder extending from the floor of trench/excavation to at least 3 feet above top of excavation, located as to provide means of exit without more than 25 feet of lateral travel. Excavations will be barricaded and posted with warning signs for the safety of personnel. Warning lights will be provided during hours of darkness.

C. The Contractor shall ensure employees working in or around excavation projects are trained and familiar with the safety requirements in 29 CFR 1926. 650 – 652 (Subpart P).

D. Prior to commencing any operations which include digging, excavations, or soil borings, etc. where there is considerable doubt of the location of concealed utilities, the Contractor shall de-energize or turn off all hazardous utilities to the building and surrounding areas.

E. When de-energizing is not possible, a waiver shall be required to allow work to continue. The waiver shall provide rationale detailing how the safety of the workers will be maintained. The waiver shall be approved by the Facilities Management Office project manager and the MSFC Industrial Safety Office.

3.18 EXPLOSIVES

A. Explosives shall not be permitted on Government Property. This prohibition does not include the explosive cartridges/devices required to operate powder actuated tools.

3.19 SIGNS

A. Construction Identification Sign: Within 30 days after Notice to Proceed, the Contractor shall install the Government-furnished construction identification sign at the location designated by the Contracting Officer. This sign shall be securely installed in an acceptable manner approved by the Contracting Officer and shall be maintained in good condition and returned to the Government at project completion.

B. Other Signs and Advertisements: Only signs necessary to expedite deliveries, maintain traffic flow, promote safety (e.g. caution, danger, blasting, hardhat area), and prevent interference with Government operations shall be erected.

3.20 JOBSITE TRAILER (FOR GOVERNMENT)

A. Contractor shall provide an approximately 500 square foot trailer at the jobsite for use solely by the Government and government representatives. Contractor shall provide the original and four copies of the keys to the trailer; no one else shall have a key to this trailer. Trailer shall be heated and cooled and custodial services shall be provided at least once per week. Trailer is to be located adjacent to the superintendent's trailer. A refrigerator with at least 14 cubic feet and -potable water shall be provided for sole use by the Government. Trailer shall be divided into four (4) rooms: an office at each end, a restroom equipped with sanitary sewer services including running water, and a common area in the middle for drawings, files, and small meetings. Submit layout drawing for COR's review and approval.

Attachment to Chapter 20, EP 1110-1-18, Ordnance and Explosives Response
UXO Personnel Training and Experience Hierarchy

Position Description	Training Required (Notes 1, 2, & 3)	Minimum Years of EOD/UXO Experience (Note 4)	Special Requirements
UXO Safety Officer	1, 2, or 3	10 years	Experience in all phases of UXO remediation and applicable safety standards
UXO Quality Control Specialist	1, 2, or 3	10 years	Experience in all phases of UXO remediation and the transportation, handling, and storage of ordnance and explosives materials
Senior UXO Supervisor	1, 2, or 3	15 years	Significant experience in all aspects of UXO remediation. Five years' experience in supervisory positions
UXO Technician III	1, 2, or 3	10 years	Prior military EOD and/or commercial UXO experience
UXO Technician II	1, 2 --- Or 3	N/A --- 5 years	Prior military EOD experience --- Experience in UXO remediation/range clearance operations. Plus specific project/ordnance training
UXO Technician I	1, 2, or 3	0	Successfully completed DOD certified course of instruction appropriate to this skill level
UXO Sweep Personnel	Equipment and site specific training	N/A	Equipment and site specific training. (Experience at this position is not required for UXO Technician I certification.)

Notes:

1. Graduate of the Army Bomb Disposal School at Aberdeen, MD.
2. Graduate of the Naval EOD School.
3. Graduate of a Department of Defense certified UXO Training Program.
4. This is the minimum experience requirement for designation. This is not an automatic designation, but reserved for those who have demonstrated the requisite knowledge, maturity, judgment, and are recommended by the contractor for recognition at the specified skill level.

END OF SECTION

SECTION 01 06 10 — GENERAL SAFETY AND ENVIRONMENTAL HEALTH REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES

A. The publications listed below form a part of this contract as required by law or as referenced:

B. Code Of Federal Regulations (CFR)

1. Executive Order 13423 Strengthening Federal Environmental, Energy, and Transportation
2. 29 CFR Part 1910 Occupational Safety and Health Standards
3. 29 CFR Part 1926 Safety and Health Regulations for Construction
4. 40 CFR Parts 1- 1068 Protection of Environment

C. NASA/MSFC Publications

1. NPR 3792.1 Plan for a Drug-Free Workplace
2. NPR 8621.1 Safety Standard for Fire Protection
3. NPR 8715.1 NASA Occupational Safety and Health Programs
4. NPR 8715.3 NASA General Safety Program Requirements
5. NPR 8820.2 Facility Project Requirements
6. NASA-STD-8719.11 Safety Standard for Fire Protection
7. MPR 1800.3 MSFC Sanitation Program
8. MPR 1840.4 MSFC Asbestos Program
9. MPR 1860.1 MSFC Radiation Safety Procedural Requirements
10. MPR 1860.2 Nonionizing Radiation Safety
11. MPD 1860.2 Radiation Safety Program
12. MPD 8500.1 MSFC Environmental Management Policy
13. MPR 8500.1 MSFC Environmental Engineering and Occupational Health Program
14. MPR 8500.2 MSFC Environmental Management System (EMS)
15. MWI 1800.1 MSFC Occupational Medicine
16. MWI 1810.1 Automated External Defibrillator (AED) Program
17. MWI 1840.1 Industrial Hygiene Program
18. MWI 3410.1 Personnel Certification Program
19. MWI 8540.2 Green Purchasing Program
20. MWI 8550.1 Waste Management
21. MWI 8550.2 Storm Water Management
22. MWI 8550.3 Wastewater Compliance

23. MWI 8550.4 Air Emissions Compliance
24. MWI 8550.5 Hazardous Material Management
25. MWI 8621.1 Mishap and Close Call Reporting and Investigation Program
26. MPR 8715.1 Marshall Safety, Health, and Environmental (SHE) Program
27. MWI 8715.1 Electrical Safety Program
28. MWI 8715.2 Control of Hazardous Energy (Lockout/Tagout) Program
29. MWI 8715.10 Explosives, Propellant, and Pyrotechnics Program
30. MWI 8715.11 Fire Safety Program
31. MWI 8715.12 Safety, Health & Environmental Finding Tracking System (SHEtrak)
32. MWI 8715.13 Safety Concerns Reporting System (SCRS)
33. MWI 8715.15 Ground Operations Safety Assessment Program
34. MWI 8715.17 Hazardous Operations Readiness Review Program

D. Fire Protection

1. National Fire Protection Association (NFPA) codes
2. NFPA 241 “Standard for Safeguarding Construction, Alteration, and Demolition Operations“
3. NASA FAR Supplement 1852.223-73 Safety and Health Plan

E. NOTE 1: These documents can be accessed through the Marshall Integrated Document Library (MIDL) located on MSFC “Inside Marshall” Webpage or by contacting the Facilities Management Office (FMO) Contracting Officer Representative (COR).

F. NOTE 2: The applicable document listing above is not intended to relieve the Contractor of its responsibility for identification of applicable regulations and procedures and compliance therewith when performing work at the Center.

1.3 SUBMITTALS

A. A Contractor Safety, Health and Environmental (SHE) plan shall be submitted in accordance with Section 01 33 00 “Submittals,” in sufficient detail to shown full compliance with the contract documents.

B. The Contractor shall submit a Contractor SHE Plan that establishes the contractor’s approach for implementing an industrial safety, occupational health, and environmental program that provides a workplace that is free from recognized hazardous conditions and is incident and injury free by (1) preventing employee fatalities, (2) reducing the number and severity of employee injuries and illnesses, and (3) protecting the environment through the ongoing planning, implementation, and management control of these programs in accordance with the Center specific requirements and regulations identified in MPR 8715.1.

C. Current Federal, State, local laws and NASA and Center specific regulations, ordinances, codes revisions shall be utilized, unless authorization to use obsolete reversions has been properly documented.

D. The Contractor’s SHE Plan shall be written specifically for the work to be performed at MSFC and provide a clear description of the Contractor’s approach for implementing their SHE Program at MSFC over the duration of this contracted effort.

E. The Contractor shall submit their SHE Plan to the FMO CO as directed in this section for review and approval prior to the contractor being notified to start work in accordance with the requirements in NPR 8820.2, MPR 8715.1 and NASA FAR Supplement 1852.223-73.

F. The Contractor's SHE Plan shall address in sufficient detail their methods for implementing each of the following five (5) MSFC SHE Core Program Requirements (CPR) described in MRP 8715.1 while performing work at MSFC under this contracted effort. At MSFC, the topics listed below each CPR are considered as minimum fundamentals necessary to fulfill the CPR.

1. CPR 1 - Management Leadership and Employee Involvement

    a. Policy to provide a safe and healthful work environment free from recognized hazardous conditions.
    b. Accountability and responsibility for employees to perform work in a safe and healthful manner without endangering other employees or damaging property.
    c. Authorization and necessary resources to reduce hazardous conditions in the work area to a safe working level.
    d. Safety meetings and awareness training provided regularly to employees.

2. CPR 2 - Worksite Analysis

    a. Safety/risk assessments or hazard analysis of worksites, jobs and operations are performed to identify hazardous conditions and reduce these hazardous conditions to a safe working level.
    b. Worksites, jobs, and operations considered as hazardous are identified and communicated to employee.
    c. Worksite inspections are performed regularly to identify hazardous conditions.
    d. Employees are allowed to report safety-related concerns to management without fear of reprisal.
    e. Safety, health, and environmental services are provided at the worksite as needed.
    f. Mishaps and close calls are reported and investigated to the extent necessary to determine the cause.
    g. Drug tests are initiated for employees involved in mishaps and close calls as needed.

3. CPR 3 - Hazard Prevention and Control

    a. Control methods adequate to reduce hazardous conditions to a safe working level are provided and implemented.
    b. Hazardous operating procedures/instructions are provided for jobs/operations considered hazardous, as needed.
    c. Fall protection systems are provided when employees are working on elevated surfaces with unprotected sides or edges.
    d. Emergency medical services are provided as needed.
    e. Disciplinary program is implemented.

f. Emergency preparedness program is provided at the worksite as needed.

4. CPR 4 - Safety, Health and Environmental Training

   a. Hazard awareness training is provided to employees.
   b. Jobs/operations are evaluated to identify specific training needed for employees.
   c. Training is provided to employees, so they are qualified and competent to perform their jobs/operations in a safe and healthful manner.

5. CPR 5 - Environmental Management System

   a. Work activities are performed in compliance with all applicable environmental-related Federal, State, local regulations, NASA and Center requirements, and environmental-related Executive Orders.

6. Contractor format is acceptable, but it is recommended that the Contractor's SHE Plan follow the order of the MSFC SHE CPR elements shown in MPR 8715.1 or provide a matrix that clearly identifies where each MSFC SHE CPR is addressed in the Contractor's SHE Plan.

7. The COR can require the Contractor to review and sign the MSFC Alternate SHE Plan for Construction prior to being allowed to start work at MSFC. When required the Contractor shall abide by all requirements identified in the MSFC Alternate SHE Plan for Construction. See "Attachment" at the end of this section for an example of the MSFC Alternate SHE Plan for Construction.

G. Reports. In addition to documentation and reports required elsewhere in this section, the following reports shall also be submitted:

1. Safety Statics Report: The Contractor shall complete MSFC Form 4371, MSFC Contractor Accident and Safety Statistics, and submit to the CO at the end of the project with the final payroll or at the frequency specified by the CO. If the contract is for a long duration, the CO in coordination with the ISB can determine the frequency that the Form 4371 is submitted. The Contractor shall ensure the form is complete and accurate in every detail and identify any information required by the form that is not applicable to the Contractor and/or scope of work.

1.4 GENERAL SAFETY PROVISIONS

A. Contractor shall:

1. Comply with all applicable Federal, State, local laws, NASA and Center specific regulations, ordinances, codes, and orders relating to safety, health, and environmental in effect on the date of this Contract.
2. Be responsible for the control and safety and health of their employees and subcontractor employees and subcontractor employees directly supporting the Contractor and any visitors to the project site during the performance of work under this contracted effort.
3. Be responsible for ensuring their employees and all subcontractor employees

supporting them comply with all applicable Federal, State, and local laws, regulations, ordinances, codes, and orders relating to safety, health, and environmental and MSFC SHE requirements while working at MSFC.

4. Advise the FMO CO or FMO Project Manager (PM) of any special safety restriction he has established so that Government personnel can be notified of these restrictions.
5. Identify a "competent person" when required by 29 CFR 1910 or 29 CFR 1926. Post the name of this person(s) at the project site or designated meeting area where the workers gather prior to commencing work, and they shall be on the project site during any operation for which they have been identified as the "competent person." (NOTE: Use the "MSFC Emergency Telephone List" provided by FMO or ISB, or a similar format to post these names at the project site or designated meeting area.)
6. Use locks with a red case and tags with red diagonal strips containing the word "lockout" when controlling hazardous energy during construction, maintenance and servicing activities in accordance with MWI 8715.2. Contractor employees that are expected to place a lock and/or tag or perform activities where the control of hazardous energy is needed are required to attend and complete the MSFC Lockout/Tagout Training. Contact the FMO or the MSFC Industrial Safety Branch (ISB) for more information on obtaining this training. Contractors are responsible for maintaining records of the completion of this training. (NOTE: Work on energized equipment shall only be allowed under special situation in accordance with MWI 8715.1.)
7. Conduct safety meetings/awareness training/toolbox meetings weekly at a minimum and retain documentation of these meetings at the construction site. Safety meeting sign-in sheets and a general description of the items covered shall be submitted to the CO or FMO PM.
8. Perform a safety assessments [job hazard analyses (JHA's), safety, risk assessment, or Hazard Identification Safety Checklists (HIC), operating procedures, etc.] for activities performed at the worksite. These documents shall be retained at the construction site. (Hazard Identification Safety Checklists are located on the SHE web page under the "News and Information" pull down menu.
9. Provide MSFC SHE 101C, "MSFC SHE Program Construction Awareness Training" to employees. A copy of this training will be provided to the contractor by the ISB during the Pre-construction Conference. The contractor shall provide this training to all Contractor employees within 30 days of the Notice to Proceed (NTP) or their arrival at the worksite unless a different time limit is specified in the contract. It is recommended that this training be provided during a weekly safety meeting. Document the completion of this training by including the title of the training course, the names of the employees with their signatures, and the date the training was provided. Notify the COR or FMO PM that this training has been completed. Maintain documentation of this training completion and provide to the Government upon their request.
10. Maintain in an orderly fashion, make readily available and provide all safety, health, and environmental related documentation (e.g., plans, forms, reports, supervisor safety visits, inspections, correspondence, JHA's, risk assessments, checklists, SDS, logs, and evidence of employee training/certifications) to the Government, upon request.
11. Ensure employee(s) are properly trained to perform their jobs/operations and when required to wear Personal Protective Equipment (PPE) has been trained in proper PPE usage in accordance with 29 CFR 1910.132(f) and MWI 8715.15.

Documentation of this training shall be provided to the Government upon request. If training certificates are unavailable, the Contractor may elect to provide a written document that provides rationale and clearly states why the Contractor considers the employee(s) as fully trained, knowledgeable, experienced, and qualified to perform the job/operation. The written document will only be accepted in lieu of a training certificate when it is written on a document that contains the company letterhead and is signed and dated by a company official or superintend. In either case the Contractor is assuming the responsibility that the employee is trained, knowledgeable, experienced, and qualified to perform the job/operation in a safe and healthful manner.

12. Provide a worksite that is easily identified, clearly separated from other ongoing activities in the same general area and effectively barricaded to prevent accidental entry into the worksite by unauthorized employees.
13. Provide protection against damage for structures, utilities, sidewalks, pavements, and other facilities that are immediately adjacent to excavations.
14. Provide a method to restrict or limit access to the worksite to only those employees and visitors that have been granted authorization to the worksite by a company official.

B. Hazard Communication (29 CFR 1910.1200). During the Pre-Construction Conference, to be arranged by the FMO, ISB, and/or the Environmental Engineering and Occupational Health (EEOH) may discuss common safety and health requirements at MSFC and distribute handouts addressing these requirements.

C. The Government reserves the right to periodically inspect Contractor worksite with or without prior notice to the Contractor.

D. The Government assumes no liability or responsibility for the Contractor's compliance or non-compliance with any Federal, State, NASA, or Center specific requirements or regulations.

E. Fines and additional costs for violations levied against the Contractor as a result of OSHA findings, and/or installation safety, health, or environmental are the sole responsibility of the Contractor and cannot be passed through to the Government.

1.5 ACCIDENT TREATMENT AND RECORDS

A. Contractor shall post emergency first aid, ambulance information, and a list of key personnel to be contacted in times of emergency at the project site. (NOTE: Use the "MSFC Emergency Telephone List" provided by FMO or ISB, or a similar format to post these names at the project site or designated meeting area.)

B. Contractor employees may utilize government dispensary facilities located in building 4249 for injury and emergency medical treatment. Contact occupational medicine services (telephone 256-544-2390).

C. Contractor shall report all accidents and incidents that occur at their work site that can result in injury or illness serious to Contractor employee or employees to the FMO Project Manager, FMO Construction Inspector, and MSFC ISB.

1. Notify by the quickest means possible the Medical Ambulance Service and Medical Team (Telephone 911 and instruct the operator you are located at Marshall Space Flight Center and provide the building number and name of road or phone 256-544-4357 and select the appropriate option.) For non-emergency call 256-544-2390.
2. Notify ISB at 256-544-0046.

    a. Initial reporting for Type A, Type B, High-Visibility Mishaps and Close Calls – The initial reporting for these types of mishaps/close call **shall be made as soon as possible after initiating emergency response, but no later than one hour of occurrence or awareness.**
    b. Initial reporting for Type C, Type D, Low-Visibility Mishaps and Close Calls– The initial reporting for these types of mishaps/close calls **shall be reported as soon as possible after initiating emergency response, but no later than four hours of occurrence or awareness.**

3. Notify the FMO CO, COR, Project Manager, or Government Construction Inspector.

D. The Contractor shall provide perform investigations and provide follow-up actions for reported accidents and incidents in accordance with MWI 8621.1, “Mishap and Close Call Reporting and Investigation Program.”

1.6 FIRE PREVENTION AND PROTECTION

A. Contractor shall comply with all fire prevention measures described in MWI 8715.11, “Fire Safety Program.”

B. The Contractor shall obtain permission from the MSFC Authority Having Jurisdiction (AHJ) for fire protection, ISB, or Fire Chief for the use of open flame devices, such as blowtorches, portable furnaces, tar kettles, or gas and electric welding and cutting equipment, in, on, or within 25 feet of buildings.

C. Open-flame heating devices are not permitted except by approval of a hot work permit by ISB in accordance with MWI 8715.11, Fire Safety Program. Approval for the use of open-flame heating devices or open-fires does not relieve the Contractor from the responsibility for any damage incurred as a result of a fire.

D. Hot Work Permits are issued by ISB in accordance with the requirements MWI 8715.11, Fire Safety Program. Details for requesting a hot work permit will be provided by the ISB representative during the Pre-Construction Conference.

E. Burning trash, brush, or wood on the project site shall not be permitted.

F. Employees shall not be permitted to smoke inside any building located at MSFC (temporary, permanent, or under construction).

G. Contractor shall be liable for any fire loss to Government property attributable to negligence on the part of the Contractor, including failure to comply with fire prevention requirements in NASA STD 8719.11 and MWI 8715.11.

1.7 ELECTRICAL

A. Contractor shall appoint an employee to serve as the "competent employee" for electrical safety. This employee shall have received training in the hazards of electricity and be familiar with the safety requirements in 29 CFR 1926. 400 – 449 (Subpart K) to be responsible for the electrical safety of the contracted effort and to restrict entry to dangerous locations to only those authorized by him and the FMO.

1.8 CONFINED SPACE ENTRY

A. The contractor shall obtain a permit prior to entering and accomplishing work in a designated confined space. At least 10 days prior to commencing activities, the contractor or sub-contractor shall submit to EEOH and ISB the following for review:

1. Training records showing personnel that have been trained in confined space entry in accordance with OSHA standard 29 CFR 1910.146.
2. Communication on company letterhead and signed by an officer or supervisor of the company stating that all personnel who are to work in the confined space entry have had appropriate training, physicals, and are fit to safely perform the role they are assigned. The letter shall call out who are to act as entrants, attendants, and entry supervisors. At no time shall the person performing the job of Entry Supervisor also be an entrant unless another designated Entry Supervisor is present and duties are transferred.
3. A copy of the company's written confined space entry program.
4. Submission of this information earlier than 10 days is encouraged since failing to comply with this section can lead to delays and completion penalties.

B. Contractor shall be responsible for removing water and debris before commencement and during execution of work in manholes.

C. Contractor shall furnish their own atmospheric testing equipment and have one or more employees properly trained in operation of the testing equipment and formally qualified as Confined Space Entry Supervisors who shall be on duty during times workers are in confined spaces in accordance with 29 CFR 1910.146(g) & (j). Their primary functions shall be to perform the duties of Confined Space Entry Supervisor and to test for atmospheric hazards and operate testing equipment. Unless equipment of constant supervisory type with automatic alarm is employed, atmospheric tests shall be made at least every 30 minutes or more often when character of ground or experience indicates gas may be encountered. An atmospheric test shall be made before workers are permitted to enter the space after an idle period exceeding one-half hour, or more frequently at the discretion of the Contractor's Entry Supervisor or by direction of EEOH or ISB. A duly designated Confined Space Entry Supervisor may borrow atmospheric testing equipment from NASA's EEOH office, if the equipment is available.

D. Special requirements, coordination, and precautions will apply to areas that contain a hazardous atmosphere or, by virtue of their use or physical character, may be oxygen deficient. Consultation with and approval by EEOH and ISB is required prior to entering these types of confined spaces.

E. All manholes associated with water, sewer, steam, electrical, communication or any other utility are considered permit-required confined spaces and must be treated as such for entry.

1.9 RADIATION SAFETY REQUIREMENTS

A. The Contractor shall comply with 29 CFR1926.53, MPR 1860.1, and MPD 1860.2 for use of all radioactive material. The Contractor shall notify the MSFC Radiation Safety Officer (RSO) at least 48 hours in advance of any planned radiography. However, if planned during a weekend, notice shall be provided by Thursday. The Contractor shall report to the RSO once on-site and prior to starting work.

B. Loss of radioactive material shall be reported immediately to the CO and RSO.

C. Actual exposure of the radiographic film or unshielding the source shall not be initiated until after 5:00 p.m. on weekdays, unless prior approval is obtained from the COR and RSO to accomplish such activities prior to 5:00 p.m.

D. In instances where radiography is scheduled near or adjacent to buildings or areas having limited access or one-way doors, no assumptions shall be made as to building occupancy. Where necessary the CO will direct the Contractor to conduct an actual building entry, search, and alert. Where removal of personnel from such a building cannot be accomplished and it is otherwise safe to proceed with the radiography, a fully instructed employee shall be positioned inside such building or area to prevent exiting while external radiographic operations are in process.

E. Contractor shall perform a hazard analysis (HA) when lasers are used or are in the work area. The HA shall be reviewed and approved by the RSO and ISB, and communicated to all personnel and all necessary protective measures taken.

1.10 TEMPORARY HANDRAILS AND GUARDRAILS (29 CFR 1910.23 and 29 CFR 1926 Subpart M – Fall Protection).

A. Temporary hand rails shall be provided on all stairwells until permanent hand rails are installed. All floor and wall openings from which there is a drop of more than 4' or there is a potential for employees to fall to a lower level shall be guarded by rail. Where there is exposure below of falling materials, a removable toe board or equivalent shall also be provided. In places where people are required to access an area close to or underneath walkways, handrails, and toe boards, approved netting shall be used.

B. Personal Fall Arrest Systems (PFAS) shall be provided to employees when they work on elevated surfaces where another fall protection system does not provide adequate fall protection. Employees shall be trained in the proper use and care of PFAS. Documentation of this training shall be provided to the Government, upon request.

1.11 TOOLS, HAND AND POWER (29 CFR 1910.241-244 (Subpart P), 29 CFR 1926.300-307 (Subpart I).

A. Hand and power tools shall be in a safe operating condition and operators shall be familiar with their safe operations.

B. All portable electrically-powered tools used on this work shall be grounded by means of a 3-wire polarity type grounding system via ground fault interrupter unless the tool is UL-listed as double-insulated. Operators of power-operated tools shall be familiar with their safe operation in accordance with 29 CFR 1910.241 -244 (Subpart P) and 29 CFR 1926.300 – 307 (Subpart I).

C. Operators of explosive activated tools shall be trained to operate such tools in accordance with 29 CFR 1926.302(e) and provide documentation of this training to the Government, upon request.

1.12 WELDING, FLAME CUTTING, AND MELTING (MWI 8715.11, NFPA 241, 29 CFR 1926.350-354 (Subpart J)).

A. Contractor shall inform ISB of any welding and cutting operations and obtain a hot work permit before beginning the operations in accordance with MWI 8715.11.

B. Contractor shall ensure welding and cutting operators are familiar with the safe operation of welding and cutting equipment requirements in 29 CFR 1926.350 -354 (Subpart J).

C. Contractor shall discontinue burning, welding, or cutting operations 1 hour prior to the end of the normal work day. A workman shall remain at the site for 1 hour, or as required by the Hot Work Permit (MSFC Form 1155), after discontinuing these operations to make a thorough inspection of the area for possible sources of latent combustion. He shall be equipped with two full 15-pound (6.8 kilogram) carbon dioxide fire extinguishers. Details for reporting fires will be provided by the ISB representative during the Pre-Construction Conference.

D. During operations involving possible fire hazard, the Contractor shall notify the CO and/or Government Inspector and not proceed until clearance is obtained in writing. CO and/or Government Inspector may request a standby from the Fire Station. This requirement does not relieve the Contractor of his responsibility for welding and cutting safety.

E. Roofing/Tar Melting/Handling Devices shall comply with the requirements of NFPA 241. Tar melting kettles and handling devices shall be used in a safe manner to eliminate any chance of an employee being burned or starting a fire. Melting kettles shall be placed on a level, firm foundation and protected against traffic, accidental tipping, or similar hazard. An approved type of fire extinguishers shall be available at all locations where melting kettles or heating devices are in use. Melting kettles or heating devices, when in use, shall be provided with a lid and thermometer.

F. Any employees designated to serve as a “Fire Watch” during welding, flame cutting, and melting shall be trained in the use of fire-extinguishing equipment, familiar with the procedures for sounding an alarm in the event of a fire, and monitor the area where the

hot work operation was conducted for at least 30 minutes after completion of the hot work operation to detect and extinguish any smoldering fires. Documentation of this training shall be provided to the Government upon request.

1.13 HIGH NOISE LEVEL PROTECTION (29 CFR 1910.132(f))

A. Contractor shall ensure employees wear appropriate hearing protection when performing operations that involve the use of equipment with output of high noise levels (jackhammers, air compressors, and explosive device activated tools) and shall be scheduled for weekends or after duty working hours as directed at the pre-construction conference. Use of any such equipment shall be approved in writing by the CO prior to commencement of work.

B. When the sound pressure level in any working area exceeds 85 dBA, personnel shall be required to wear hearing protective devices in accordance with 29 CFR 1926.101.

C. When the sound pressure level in any work area exceeds 120 dBA, hearing protection equivalent to the combination of ear plugs and ear muffs shall be required.

1.14 SEVERE STORM EVACUATION PLAN

A. In the event of a severe storm warning, the Contractor shall:

1. Secure outside equipment and materials and place materials possible to damage in protected locations.
2. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.
3. Vacate temporary construction trailers
4. Go to the nearest protective area identified by the FMO PM.

1.15 SCAFFOLDS AND LADDERS (29 CFR 1926 Subpart L, 29 CFR 1926.454, 29 CFR 1910.66, 29 CFR 1910.28-29 and 29 CFR 1910.24-27)

A. The Contractor shall comply with the requirements of 29 CFR 1926 Subpart L and 29 CFR 1910.66 for use of scaffolds. All scaffolds, ladders, platforms, and runways shall be erected, inspected, and maintained in accordance with the applicable sections listed above.

B. An adequate number of ladders shall be furnished at all times. Job constructed ladders shall be of select materials. All fixed ladders above 20 feet in height shall be staggered or caged. All ladders placed on concrete floors or slippery surfaces shall be equipped with an approved type no-skid shoe or otherwise adequately made to prevent slipping.

1.16 ROPES/SLINGS/CHAINS

A. No loads shall pass over workmen and other personnel at any time. Slings, their fittings and fastenings, when in use, shall be inspected daily by a qualified craft person for evidence of overloading, excessive wear, or damage. Defective slings shall be removed

from service. Proper storage shall be provided for qualified slings when not in use. Wire rope shall be inspected by a competent person at the time of installation and at scheduled intervals thereafter. Drums, sheaves, or pulleys having eccentric bores or cracked hubs, spokes, or flanges shall be removed from service. To eliminate rope damage: drums, sheaves, and pulleys shall be smooth and free of surface defects.

B. Connections, fittings, fasteners, parts, etc., used in connection with ropes shall be of good quality and of proper size and strength, and shall be installed in accordance with recommendations of the manufacturer. Chains used for lifting loads shall be inspected before each use. After the initial inspection, the chains shall be inspected each week. Chains shall be removed from service when showing evidence of cracks, nicks, or other damage. All hooks, used to support human loads (on approved lifting devices) or any loads, shall be closed or equipped with a safety latch.

C. Hooks, shackles, rings, pad eyes, and other fittings that show excessive wear or that have been bent, twisted, or otherwise damaged shall be removed from service. Frozen fiber rope shall not be used. Fiber rope that has been subjected to acids or excessive heat shall not be used. Fiber rope shall be protected from abrasion by padding where it is fastened. The same protection applies for fiber rope drawn over square corners, sharp or rough surfaces.

D. The Contractor shall ensure employees performing rigging and hoisting operations are trained and familiar with the safety requirements in 1926.753 and 761. Documentation of this training shall be provided to the Government upon request.

1.17 OPERATIONS ADJACENT TO POWER LINES

Power Lines Nominal System KV	Minimum Required Clearance (Feet)
5	3
15	8
44	10
69	12
115-161	15

A. Equipment or any part thereof shall not have the capability of coming within the following minimum clearances from energized power lines. Positioning and blocking of equipment to assure that no part thereof, including cables, can come within the following minimum clearances will be considered an acceptable alternate.

B. A notice of the minimum required clearance shall be posted at the operator's position.

C. The Contractor shall ensure employees performing operations adjacent to power lines are trained and familiar with the safety requirements in 29 CFR 1926. 950 – 960 (Subpart V). Documentation of this training shall be provided to the Government upon request.

1.18 CONSTRUCTION EQUIPMENT

A. All construction equipment and machinery, including required guards, brakes, cable, etc., shall be inspected by qualified personnel before use for safe and serviceable mechanical condition. All inspections shall be done daily before each shift and will be properly maintained by qualified personnel. A warning device or service of a Signal-man shall be provided where there is danger to personnel from moving equipment, swinging loads, buckets, booms, etc. All equipment capable of hauling 5 tons of material is considered to be heavy duty and shall be equipped with an emergency brake system. The State Commercial Driver's License (CDL) requirement and regulation applies on Redstone Arsenal. Documentation of this training shall be provided to the Government upon request.

B. Before any machinery or mechanized equipment is placed in use, it shall be inspected and tested by a competent mechanic and certified to be in safe operating condition. Records of tests and inspections will be maintained at the site and will be available to the Government upon request. All machinery or equipment found to be unsafe shall be tagged out and its use prohibited until unsafe conditions have been corrected. Machinery or equipment requiring an operator shall not be permitted to run unattended. Equipment shall be locked or secured to prevent operation by unauthorized personnel. All guards and devices shall be replaced immediately after completion of repairs and adjustments.

C. The Contractor shall ensure employees working with construction equipment are trained in its safe operation and are familiar with the safety requirements in 29 CFR 1926. 600 – 606 (Subpart O). Documentation of this training shall be provided to the Government upon request.

D. Self-propelled construction equipment (except light service vehicles), crawler-type equipment, such as cranes, power shovels and draglines, whether moving alone or in combination shall be equipped with a reverse signal alarm in accordance with 29 CFR 1926.601.

1. The alarm shall be mounted on the rear of the equipment and shall withstand severe wear and tear, adverse weather, and unfavorable environmental working conditions and shall be certified by the manufacturer as fully meeting the following performance standards.
2. The alarm shall produce a relatively pure tone which shall peak within the United Standard Association standard octave passband of 600 to 2,400 cycles per second and shall produce a 0.2 to 0.5 second audible warning within the initial 3 feet of backward movement of the vehicle on which it is mounted and at regular intervals, not to exceed 3 seconds, throughout the backward movement. The alarm shall automatically cut out when the backward movement ceases. The sound intensity of the alarm shall range from and not exceed 100 dB at a horizontal distance of 5 feet from the alarm.
3. Actuation of the alarm shall be automatic by direct connection to any part of the equipment that moves or acts in a manner distinctive only to the rearward movement of the vehicle with no manual controls of any kind between the source of actuation and the alarm. Where application of this requirement to specific types of equipment has impractical application, other means of actuation may be used upon written approval of the CO.

1.19 TEMPORARY ELECTRICITY AND LIGHTING

A. All temporary wiring shall be in accordance with the National Electric Codes, OSHA standards, and installed by competent personnel. Adequate, safe lighting shall be provided in advance for any work requiring artificial light. Grounding of all electrical portable equipment and hand tools shall be accomplished by installing three-wire plug systems. All 120 volt, single-phase, 15 and 20 ampere receptacle outlets on construction sites which are not part of the permanent wiring of the building or structure and which are in use by employees shall have approved ground fault circuit interrupters (GFCI) for personnel protection.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

Alternate Safety, Health and Environmental (SHE) Plan for Construction

Company Name:	
Contract Number:	**Date:**
MSFC Organization supported:	
MSFC Contracting Officer:	
MSFC Contracting Officer Representative:	
Contract begin date:	**Contract End date:**

Marshall Space Flight Center (MSFC) is committed to providing a workplace that is incident and injury free by (1) preventing employee fatalities, (2) reducing the number and severity of employee injuries and illnesses, and (3) protecting the MSFC environment and property by implementing the five (5) MSFC SHE Program Core Program Requirements (CPRs). During (or for the duration of) the construction, alteration, demolition and/or repair of this contracted effort shall:

_____

(company name)

CPR 1 – Management Leadership and Employee Involvement

1. Provide a visible management commitment, policy, and culture that value the safety and health of employees and provides a safe and healthful workplace free from incidents and injuries.

2. Protect MSFC property and the environment over the duration of this contracted effort.

3. Perform work activities and operations in compliance with EPA, OSHA, NASA, MPR 8715.1 and all MSFC SHE documents listed in 1.02B that contain requirements applicable to this contracted effort.

4. Hold supervisors and employees accountable to perform their work activities in a safe and healthful manner and also understand their roles and responsibilities in the SHE Program.

5. Authorize and provide the necessary resources for the elimination, reduction or for controlling identified hazardous conditions to a safe working level.

6. Evaluate the safety performance of subcontractors or teammates prior to their selection to perform any work in support of this contracted effort, where applicable.

7. Flow down responsibilities and requirements contained in this contracted effort to subcontractors and teammates over the duration of this contracted effort, when applicable.

8. Provide SHE meetings/toolbox meeting/safety awareness training to employees at least weekly and document. (**NOTE**: Contractors shall maintain documentation of these meetings and provide to the Government, upon request).

9. Maintain the SHE Plan current with contract, NASA and MSFC requirements, review and update as necessary. Provide the frequency of this review.

10. Provide the identification, by title, of the individual assigned by the contractor to be responsible to implement the contractor's SHE program elements and designated to serve as the day-to-day SHE Point of Contact (POC) for this contracted effort. [**NOTE:** The names of these employees shall be posted on the attached Emergency Phone listing.]

CPR 2 – Worksite Analysis

11. Evaluate work areas, jobs and operations by the use of job hazard analysis, safety or risk assessments, or hazard identification safety checklists to identify hazardous conditions and implement the appropriate control measures to eliminate, reduce or control hazardous conditions to an acceptable safe working level.

12. Reevaluate work areas, jobs and operations when significant changes are made to verify that existing control measures are still effective in controlling the hazardous conditions. (**NOTE 1**: This also includes evaluating health conditions to identify and prevent an occupational disease.) (**NOTE 2**: Contractors shall maintain documentation of these evaluations and provide to the Government, upon request).

13. Perform worksite safety inspections of the worksite at least weekly and document. (NOTE: Contractors shall maintain documentation of these inspections and provide to the Government, upon request).

14. Encourage employees to report any condition that they feel is hazardous or unsafe without the fear of reprisal from management.

15. Report all contractor mishaps and close calls that occur in support of this contracted effort and investigate to the extent necessary to determine the proximate or root cause(s), develop and implement corrective actions, and track to closure in accordance with MWI 8621.1. Contact the CO, FMO Project Manager or MSFC Industrial Safety Branch for assistance if needed.

16. Perform post-mishap drug and alcohol testing when the initial mishap investigation provides reason to believe an employee's actions or failure to perform a required action is reasonably suspected of having caused or contributed to causing the mishap in accordance with NPR 3792.1, "Plan for Drug-Free Workplace."

CPR 3 – Hazard Prevention and Control

17. Perform a supervisor level review for work activities identified as hazardous or safety critical prior to them being started.

18. Perform work at MSFC in full compliance with the MSFC SHE documented programs listed in 1.02B that contain requirements that are applicable to this contracted effort while working on-site at MSFC (e.g., Personal Protective Equipment (PPE), Respiratory Protection, Hazard Communication, Confined Space Entry, Lockout/Tagout, Bloodborne Pathogens).

19. Provide an emergency management program at the worksite for all types of emergencies that can occur during this contracted effort (e.g., fire, chemical spill, accidents, natural disasters). (NOTE 1: Contractors located at the Center, when applicable, should contact their Contracting Officer or Contracting Officer Representative for additional instructions.) (NOTE 2: A

list of emergency phone numbers and points-of-contacts is recommended to be posted at the worksite for employee reference.)

20. Provide the necessary safety, health, and environmental services at the worksite (i.e., hazardous waste disposal, industrial hygiene monitoring, emergency medical support, hearing conservation program, respiratory protection, and hazard communication, etc.). Provide a list of environmental and health services that will not be provided by MSFC.

21. Provide a worksite that is easily identified, clearly separated from other ongoing activities in the same general area and effectively barricaded to prevent accidental entry into the worksite by unauthorized employees.

22. Provide protection against damage for structures, utilities, sidewalks, pavements, and other facilities that are immediately adjacent to excavations.

23. Provide fall protection to employees that will be walking/working surfaces with unprotected sides or edges where the potential exists for them to fall to the next lower level in accordance with 29 CFR 1926.501, 29 CFR 1926.502, 29 CFR 1910.23 and MPR 8715.1.

24. Develop a “site specific (building) fall protection plan” when a conventional fall protection system cannot be used to provide fall protection at the worksite and submit for approval to the COR and MSFC Industrial Safety Branch (ISB) in accordance with 29 CFR 1926.501(k) and MPR 8715.1.

25. Develop operating procedures/instructions for operations identified as hazardous or safety critical, or when directed by MSFC ISB, EEOH or FMO.
[**NOTE**: The operating procedures/instructions shall be documented, clearly identify the potentially hazardous situations, the mitigation techniques necessary to control the concern/hazard, and made available to the Government upon request.]

26. Provide a method to restrict or limit access to the worksite to only those employees and visitors that have been granted authorization to the worksite by a company official.

CPR 4 – Safety, Health and Environmental Training

[NOTE: The preferred method documenting an employee’s training is to provide a certificate of training that contains (1) the name of the training, (2) date the training was provided, (3) name of the company that provided the training, and (4) the employee’s name that indicates the employee attended the training and met all training requirements. In cases where a certificate of training is unavailable for an employee the Contractor can elect to provide an alternate documentation of employee training. The alternation documentation shall (1) be written on a document that contains the company letterhead, (2) rationale that clearly states why the employee is considered as trained, knowledgeable, experienced, and qualified to perform the job/operation, and (3) signed and dated by an a company official or supervisor. In either case the Contractor is assuming the responsibility that the employee is trained, knowledgeable, experienced, and qualified to perform the job/operation in a safe and healthful manner.

27. Provide training to employees so they are informed, knowledgeable and are able to recognize hazardous conditions in the workplace and the signs and symptoms of workplace-related illnesses, understand the safe work practices and procedures to be used in the workplace, and are empowered and authorized to “stop or halt” any activity when they have reason to suspect

the activity is being performed in an unsafe or unhealthy manner in accordance with 29 CFR Part 1926.21(b)(2). [**NOTE**: This training can be accomplished during a safety (toolbox) meeting and evidence of this training made available to the Government upon request.]

28. Clearly communicate to all employees the contractor's disciplinary policy/program, so that each employee fully understands the actions that can be taken by the contractor when an employee is discovered not following safety, health, and environmental policies, procedures and rules, and the disciplinary actions are warranted.

29. Evaluate each job/operation performed by contractor employees to identify the specific training required by the applicable parts of 29 CFR 1910 and 29 CFR 1926, and provide the specific training to employees prior to them performing the job/operation.

a. Operate Contractor owned equipment and machinery in accordance with 29 CFR 1926.20(a)(4)
b. Handle or use poisons, caustics, and other harmful substances in accordance with 29 CFR 1926.21(b)(3).
c. Enter into confined or enclosed spaces in accordance with 29 CFR 1926.21(b)(6). [**NOTE**: At MSFC all manholes associated with water, sewer, steam, electrical, communication or any other utility are considered permit-required confined spaces and must be treated as such for entry. This includes provisions such as, but not limited to, written confined space program, documentation of appropriate training, atmospheric testing and retrieval equipment.]
d. Operate any MSFC owned lifting equipment (forklift, crane, etc.) in accordance with MWI 3410.1.
e. Perform rigging and hoisting operations in accordance with 29 CFR 1926.753-761 and 29 CFR 1910.178(l)6).
f. Perform operations adjacent to power lines in accordance with 29 CFR 1926.950-960.
g. Operate or use construction equipment considered as heavy equipment or machinery in accordance with 29 CFR 1926.600-606.
h. Wear personal fall arrest system in accordance with 29 CFR 1926.503.
i. Wear Personal Protective Equipment in accordance with 29 CFR 1910.132.
j. Designated as "qualified" to operate equipment and machinery, and perform the work activities that they have been assigned in accordance with the applicable parts of 29 CFR 1910 and 29 CFR 1926.
k. Designated as "competent person" for any operation identified in 29 CFR 1910 or 29 CFR 1926 that require a "competent person."
(**NOTE**: Contractors shall maintain documentation of this training and provide to the Government.)

30. Provide MSFC SHE Program Awareness Training to all employees within 30 days of the Notice to Proceed (NTP) or their arrival at the worksite. [**NOTE** 1: Contact Facilities Management Office (FMO) Project Manager or Industrial Safety Branch (ISB) to receive a copy of this training. **NOTE** 2: Contractors shall maintain a record of this training and made available to the Government, upon request.]

31. Provide MSFC Safety Certification to employees when required by the ISB or Environmental Engineering and Occupational Health (EEOH) Office. (**NOTE**: At the present time if the Contractor is expected to operate MSFC owned lifting equipment in accordance with MWI 3410.1 a MSFC Safety Certification is required.)

32. Inform all employees on the methods of how to report an emergency or accident while working at MSFC. [**NOTE**: Call 4-HELP (4357) and select the appropriate option. If using a cell phone call 911 and tell the operator you are located at Marshall Space Flight Center, provide building number and road name.]

CPR 5 – Environmental Management System

33. Comply with the MSFC Environmental Management System (EMS). The EMS provides the necessary training and procedures to ensure NASA's compliance with all environmental laws and regulations. Environmental procedures are as follows:

a. MPD 8500.1 "MSFC Environmental Management Policy"
b. MPR 8500.1 "MSFC Environmental Engineering & Occupational Health (EEOH) Program"
c. MPR 8500.2 "MSFC Environmental Management System"
d. MWI 8540.2 "Green Purchasing Program"
e. MWI 8550.1 "Waste Management"
f. MWI 8550.2 "Storm Water Management"
g. MWI 8550.3 "Wastewater Compliance"
h. MWI 8550.4 "Air Emissions Compliance"
i. MWI 8550.5 "Hazardous Material Management"

[**NOTE**: Coordination with EEOH is required.]

ADDITIONAL REQUIREMENTS

Pre-work Inspections

34. Erect and inspect scaffolds prior to use each day in accordance with 29 CFR Subpart L and 29 CFR Part 1910.66 and 29 CFR 1926.451(f)(3).

35. Dig, form and inspect excavations/trenches prior to entry and as needed throughout the day in accordance with 29 CFR 1926.651, 29 CFR 1926.652 and 29 CFR 1926.651(k).

[**NOTE**: Evidence of these inspections shall be documented and made available to the Government upon request.]

Equipment and Tools

36. Provide Contractor owned or rented hoisting equipment (cranes and forklifts) that have their rated load capacities conspicuously posted on the equipment in accordance with 29 CFR 1926.550(a)(2) if brought on MSFC.

37. Provide Contractor owned or rented motorized vehicles and lifting equipment that comply with the applicable requirements in 29 CFR 1910.178 – 184, 29 CFR 1926.606, 1000-1003, and 1501 if brought on MSFC. [**NOTE**: Documentation of equipment inspections shall be made available to the Government upon request.]

38. Provide a documented annual inspection for Contractor owned or rented hoisting equipment (cranes and forklifts) in accordance with 29 CFR 1926.550(a)(6) if brought on MSFC.

[**NOTE**: Documentation of the annual inspection shall be made available to the Government upon request.]

39. Perform a visual inspection of each hoisting equipment (cranes or forklifts) prior to use in accordance with 29 CFR 1926.753(c)(1).

40. Remove any equipment, machinery or tools if it is discovered to be in an unsafe operating condition in accordance with 29 CFR 1926.20 (a)(3).
[**NOTE**: Equipment, machinery or tools discovered in an unsafe operating condition shall be removed from the worksite or identified (tagged) as unsafe, or rendered inoperable by the use of a lock.]

41. Provide a reverse signal alarm on all self-propelled construction equipment in accordance with 29 CFR 1926.601. [**NOTE**: This is not required for light service vehicles.]

42. Locate and store equipment and materials outdoors so to not cause possible damage to other buildings or structures during severe weather.

Electrical Equipment

43. Provide power portable tools that are double-insulated or grounded by means of a 3-wire polarity type grounding system via a ground fault interrupter in accordance with 29 CR 1926.302.

44. Provide ground-fault circuit interrupters (GFCI) on all single-phase 15 and 20 ampere receptacle outlets used by employees at the worksite during the construction in accordance with 29 CFR 1926.404(b)(1).

45. Provide cord sets and receptacles that are equipped with a grounding plug and are grounded in accordance with 29 CFR 1926.404(b)(1). [**NOTE**: This applies to cord sets and receptacles that are not part of the permanent building structure.]

46. Apply lockout devices to equipment and systems when required in accordance with 29 CFR 1910.147, 29 CFR 1926.417 and MWI 8715.2. [**NOTE** 1: At MSFC all locks used for locking out equipment/system while an employee is working on the equipment/system shall be identified by a “red” colored case. These lockout devices shall also be identified with tags containing “red diagonal stripe”. Reference MWI 8715.2 for more information.] [**NOTE** 2: Work on energized equipment is strictly prohibited at MSFC, but occasionally a situation will arise where this is not possible. In these situations an Energized Electrical Work Permit shall be required. Contact FMO for more information.]

Lighting

47. Provide adequate lighting (permanent or temporary) in the work area that enables employees to safely perform their jobs/operations in accordance with 29 CFR 1926.26.

Fire Protection

48. Provide fire protection equipment that is appropriate for the work being performed at the worksite in accordance with 29 CFR 1926.24. [**NOTE** 1: Portable fire extinguishers are to be located at the worksite and accessible to employees.] [**NOTE** 2: Any employee that might use a

portable fire extinguisher are to receive training in the general principles of fire extinguisher use and the hazards involved with incipient stage firefighting in accordance with 29 CFR 1910.157.]

Barricades

49. Erect barricade fencing that is effective in preventing unauthorized entry around the worksite and hazardous conditions such as excavations, trenches, etc. in accordance with 29 CFR 1926.200 -203, Subpart G.
[**NOTE**: Orange mesh barricade fencing is the preferred method for construction at MSFC, but other means (signs, signals, tags) of warning employees are also acceptable. The FMO inspector or ISB can provide more information.]

50. Provide protection against damage for structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations.

Personal Protective Equipment

51. Communicate Personal Protective Equipment (PPE) requirements to employee whose jobs/operations can expose them to hazardous conditions in accordance with 29 CFR 1926.28 and MWI 8715.15. [**NOTE**: The communication can be by the use of signs posted at the worksite that clearly identify the type PPE and when it is required to be worn.]

Personal Fall Arrest System (PFAS)

52. Provide a system that ensure PFAS and associated positioning device systems are inspected prior to each use in accordance with 29 CFR 1926.502(d)(21) and 29 CFR 1926.502(e)(9).

53. Provide a system that ensures PFAS are inspected at least on a semi-annual basis by a Competent or Qualified person in accordance with ANSI A10.32 (2004) section 6.3).
[**NOTE**: Documentation of equipment inspections shall be made available to the Government upon request.]

Housekeeping

54. Remove all scrap lumber and debris from work areas, passageways and stairs in accordance with 29 CFR 1926.25(a).

55. Remove combustible scrap and debris from the worksite at regular intervals in accordance with 29 CFR 1926.25(b).

56. Provide waste/trash containers at the worksite empty them at regular intervals in accordance with 29 CFR 1926.25(c). [**NOTE**: Containers for garbage and other oily, flammable, or hazardous wastes, such as caustics, acids, harmful dusts, etc. shall be equipped with covers and the covers kept closed.]

Permits/Plans

57. Obtain the following abatements/impairment plans when needed for:

Lead removal – 29 CFR 1926.62

Asbestos removal - 29 CFR 1926.1101
Fire Protection system outages – 29 CFR 1926.150 and MWI 8715.11

58. Obtain the following permits when needed:

    Hot Work Permits (MSFC Form 1155) shall be required for activities that are not performed in a MSFC Designated Hot Work Area and use an "open flame", welding, cutting, grinding, Tar Kettles. etc.
    [**NOTE**: All hot work shall end 1 hour prior to the end of the normal work day.]

- Digging Permit (MSFC Form 4392) shall be required for all excavations and trenching
- Confined Space Entry Permit (MSFC Form 2519) shall be required for all entries in MSFC spaces identified as a confined space in accordance with MWI 1840.1.
- Energized Electrical Work Permit (MSFC Form 4462) shall be required if the equipment or system cannot be de-energized to perform work.
  [**NOTE**: No work shall be performed on energized equipment without concurrence from FMO and approval from ISB.]
- Air Emissions Permit (coordinate with EEOH 256-544-4246) shall be required if the equipment or process emits fumes, smoke, particles, dust, chemicals, or other emissions into the air. If the following equipment is installed on site, it shall be evaluated for air emissions permit requirements before installation:
  - Fuel burning equipment (examples: boilers, incinerators, generators, engines, etc)
  - Paint booths
  - Sand/Grit blasters
  - Surface coating equipment
  - Machine shops
  - Woodworking shops
  - Chemical baths, vapor degreasers, solvent cleaning equipment/operations
  - Air strippers/water purification
  - Tanks containing Volatile Organic Chemicals (VOC's) (examples: gasoline tanks, diesel tanks, etc.)
  - Liquid rocket engine, solid motor, or component testing
  - Vapor degreasing
  - Laboratory equipment
  - Equipment for melting or applying wax
  - Hydraulic or hydrostatic test equipment
  - Brazing, soldering, or welding
  - Non-digital photography
  - Exhaust/fume hoods
  - Parts Washers
  - Storm Water Permit

General

59. Instruct all employees on the methods to receive emergency medical attention at MSFC in accordance with 29 CFR 1926.23 & 50. [**NOTE**: First aid is available to all employees at the MSFC Medical Center, building 4249 for job related illnesses and injuries.]

60. Identified employee(s) to serve in the role of a "Competent person" for pre-job inspections/verifications/activities (scaffolding, trenches, etc.) as required by the applicable subparts of 29 CFR 1910 and 29 CFR 1926 for this contracted effort. [**NOTE** 1: A "competent person" is identified in 29 CFR 1926.32 and 29 CFR 1910 as "capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who have authorization to take prompt corrective measures to eliminate them."] [**NOTE** 2: Justification/rational of selecting these employees shall be documented (employee's training, work experience and knowledge of the job/operation) and made available to the Government upon request. The name(s) of the "Competent person(s) and the corresponding job/operation for which that are designated to serve as the "Competent person" shall be listed on the attached Emergency Phone listing, Appendix C and posted at the project site or designated meeting area where the worker gather prior to commencing work.]

61. Appoint an employee to be "in charge and responsible" and is physically located onsite while work is being performed. [**NOTE**: This is normally a job superintendent or foreman.]

62. Provide a list of company employee(s) to be contacted in the event of an emergency while work is performed onsite under this contracted effort.

63. Post the "Emergency Phone List" Appendix C at the project site, or a designated meeting area where workers gather prior to commencing work, or for other activities. The "Emergency Phone List" can also be located in company vehicles if the Contractor does not have a designated meeting area.

64. Provide additional requirements not previously listed, if required, specific to the work performed under this contracted effort in Appendix A.

65. Instruct employees to adhere to the MSFC emergency procedures when there is a probability of exposure to Unexploded Ordnance (UXO), hazardous or radiological material.

66. If Unexploded Ordnances (UXO) are suspected of being in the worksite notify the FMO Construction Management Inspector to contact the UXO services organization to perform an assessment/investigation of the worksite in accordance with the MSFC Technical Specifications for Repair and Construction (TSRC) section 01 05 90.

REPORTS/DOCUMENTATION SUBMITTAL

Reports/documentation listed below shall be made available to the Government upon request.

1. Safety (toolbox) meeting and/or safety awareness training documentation
2. Safety Assessments: Hazard Analysis (HA) or Job Hazard Analysis (JHA), Hazardous Inventory Checklists (HIC) for the work being performed
3. Worksite inspections conducted by the contractor documentation
4. Employee training/qualification/certification records
5. Equipment inspections conducted by the contractor documentation
6. Safety Data Sheets (SDS) for chemical and hazardous materials
7. Storm water inspection reports
8. Green purchasing reports
9. Construction Best Management Practices Plan (CBMPP)
10. Waste Management plan
11. Waste reduction report

SUBMISSIONS FREQUENCY

1. Submit MSFC Contractor Accident and Safety Statistics (MSFC Form 4371) or an equivalent method to the Contracting Officer (CO) or FMO representative designated by the CO. This information shall be provided to the CO in accordance to the reporting requirements and frequency determined by the CO. At a minimum the following information shall be provided:
   - Contract number
   - North American Industry Classification System (NAICS)
   - Number of employees and supervisors
   - Number of hours worked during the month
   - Lost work day cases, days away from work, and restricted work days
   - Number of safety meeting and worksite inspection

2. Initial reporting for Type A, Type B, High-Visibility Mishaps and Close Calls – The initial reporting for these types of mishaps/close call **shall be made as soon as possible after initiating emergency response, but no later than one hour of occurrence or awareness.**

2.1 Initial reporting for Type C, Type D, Low-Visibility Mishaps and Close Calls– The initial reporting for these types of mishaps/close calls **shall be reported as soon as possible after initiating emergency response, but no later than four hours of occurrence or awareness.**

2.2 Initial report shall be made to the MSFC ISB by one of the following: 1) Call the Safety Hotline at (256)-544-0046 or 4-HELP (4-4357), select the appropriate option, or 2) Submit a “SHE Report” located on “Inside Marshall,” or 3) Direct input to the NASA Incident Reporting Information System (IRIS) Quick Incident Report located at https://nasa.ex3host.com/irisquickincident/safety_default.asp., or 4) an equivalent electronic notification method to the MSFC Industrial Safety Branch.

The link to the “SHE Report” is located at the bottom of the “Inside Marshall” web page under the “MSFC Safety Reporting System” link. Open “SHE Reporting,” select “Continue to SHE Report Form,” select “Category,” select “Incident or Mishap” and enter all the required information,

2.3 The initial reporting for all mishaps/close calls shall include 1) location and time of incident, 2) number of fatalities and/or hospitalized employees (if known), 3) Company or MSFC organization contact person and phone number, 4) a brief description of the mishap/close call including damage to equipment and/or facilities.

3. Follow-up reporting and documentation of a mishap/close call shall be within 24 hours of initial notification to the FMO Incident Reporting Information System (IRIS) administrator or ISB in accordance with MWI 8621.1.

The extent of investigation to determine the root cause of the mishap or close shall be conducted in accordance with MWI 8621.1.

Approval Signatures

By signing this Alternate SHE Plan the Contactor confirms their agreement and commitment to (1) provide a workplace that is incident and injury free, and (2) to adhere to and comply with all of the requirements contained in MPR 8715.1, MWI 8621.1 and other MSFC SHE documents identified above as applicable to the jobs/operations associated with this contracted effort while working on MSFC.

Contract Number: _____

Company Name: _____

Company Onsite Superintendent/Foreman

(print):_____

(signature):_____Date:_____

Company Onsite SHE representative

(print):_____

(signature):_____Date:_____

APPENDIX A
Additional Information

List of jobs/operations identified as hazardous or safety critical.
List of hazardous operating procedures/instructions
List of JHA, Risk Assessments, or Hazard Identification Safety Checklists
List additional requirements that are specific to the work performed under this contracted effort, if necessary.

1.

2.

Appendix B
Applicable Documents

"Check the box" of the following MSFC SHE Program documents that are **NOT** applicable to the work being performed under this contracted effort.

No.		**Federal Directives and Standards**
1		29 CFR Part 1910, Department of Labor, Occupational Safety and Health Administration Standards for General Industry
2		29 CFR Part 1925, Safety and Health Standards for Federal Service Contracts
3		29 CFR Part 1926, Department of Labor, Occupational Safety and Health Administration Standards for Construction
4		CFR Title 40 Parts 1-1068, Protection of the Environment
5		ANSI Stds., American National Standards Institute, applicable to the scope of this contract (ANSI 10.32)
6		ASME, American Society of Mechanical Engineers, applicable to the scope of this contract
7		NFPA, National Fire Protection Association
8		CGA, Compressed Gas Association, applicable to the scope of this contract
		NASA Directives
9		NPR 3792.1, Plan for a Drug-Free Workplace
10		NPR 8715.1, NASA Occupational Safety and Health Programs
11		NPR 8715.3, NASA General Safety Program Requirements
		MSFC Directives
12		MPR 1800.3, MSFC Sanitation Program
13		MPR 1840.4, MSFC Asbestos Program
14		MPR 1860.1, MSFC Radiation Safety Procedural Requirements
15		MPD 1860.2, Radiation Safety Program
16		MPR 1860.2, Nonionizing Radiation Safety
17		MPR 3410.1, Training
18		MPD 8500.1, MSFC Environmental Management Policy
19		MPR 8500.1, MSFC Environmental Engineering and Occupational Health Program
20		MPR 8500.2, MSFC Environmental Management System (EMS)
21		MWI 1800.1, MSFC Occupational Medicine
22		MWI 1810.1, Automated External Defibrillator (AED) Program
23		MWI 1840.1, Industrial Hygiene Program
24		MWI 3410.1, Personnel Certification Program
25		MWI 8540.2, Green Purchasing Program
26		MWI 8550.1, Waste Management
27		MWI 8550.2, Storm Water Management
28		MWI 8550.3, Wastewater Compliance
29		MWI 8550.4, Air Emissions Compliance

30		MWI 8550.5, Hazardous Material Management
31		MWI 8621.1, Mishap and Close Call Reporting and Investigation Program
32		MPR 8715.1, Marshall Safety, Health, and Environmental (SHE) Program
33		MWI 8715.1, Electrical Safety Program
34		MWI 8715.2, Control of Hazardous Energy (Lockout/Tagout) Program
35		MWI 8715.5, Area/Building Manager Program
36		MWI 8715.10, Explosives, Propellant, and Pyrotechnics Program
37		MWI 8715.11, Fire Safety Program
38		MWI 8715.12, Safety, Health and Environmental-Finding Tracking System (SHEtrak)
39		MWI 8715.13, Safety Concerns Reporting System (SCRS)
40		MWI 8715.15, Ground Operations Safety Assessment Program
41		MWI 8715.17, Hazardous Operations Readiness Review Program
42		For Construction - Indefinite Delivery Indefinite Quantity (IDIQ) and Blanket Purchase Agreement (BPA) – MSFC Technical Specifications for Repairs and Construction (TSRC)
43		For Construction – Construction of Facilities (CoF) – MSFC Master Specs

APPENDIX C
MSFC EMERGENCY TELEPHONE LIST

[Post at worksite or a designated meeting area where workers gather prior to commencing work or for other activities. The "Emergency Phone List" can also be located in company vehicles if the Contractor does not have a designated meeting area.]

	MSFC NETWORK TELEPHONE	OTHER TELEPHONE
AMBULANCE	911	911- Specify at MSFC or 544-4357, Option (Security)
CHEMICAL SPILLS	911	544-4357, Option (Security)
Environmental Engineering Office		544-4246
FIRE	911	876-2117
SECURITY	911	544-4357, Option (Security)
MEDICAL CENTER (bldg 4249)		544-2390

[Identify that you are on MSFC property if using a cell phone and give location, building number, road, intersection, etc. if known.]

TO REPORT UNSAFE, UNHEALTHFUL OR ENVIRONMENTAL CONCERNS

OCCUPATIONAL HEALTH SERVICES	544-2390
ENVIRONMENTAL ENGINEERING OFFICE	544-4246
INDUSTRIAL SAFETY BRANCH	544-0046

TO REQUEST A PERMIT

Welding/Burning/Cutting Permits	544-0046
Inside Test Area	544-7374, 961-1178
CONFINED SPACE PERMITS (call all numbers listed below)	
Occupational Health Services	544-2390
Industrial Safety Branch	544-0046
Inside Test Area	544-7374, 961-1178
Fire Department	876-3437
Digging Permit	544-6759

Company Name:	
Company Emergency Contact:	Phone:
Company Emergency Contact:	Phone:
Company Emergency Contact:	Phone:
Company SHE POC:	Phone:
Competent SHE POC (Alt)	Phone:
Competent Person – Lifting Equip:	Phone:
Competent Person – Excavation/Trench:	Phone:
Competent Person - Scaffold:	Phone:
Competent Person - Rigging:	Phone:
Competent Person:	Phone:
Competent Person:	Phone:

END OF SECTION

SECTION 01 06 50 — ENVIRONMENTAL COMPLIANCE

PART 1 - GENERAL

1.1 SUMMARY

A. This section deals with hazardous waste, stormwater, and green purchasing. Refer to section 01 74 19 for construction waste and demolition.

1.2 REFERENCE

A. The publications listed below form a part of this section to the extent referenced:

1. MPR 1840.4, MSFC Asbestos Program
2. MWI 8540.2 Green Purchasing Program
3. Executive Order 13423 Strengthening Federal Environmental Energy, and Transportation
4. Executive Order 13514 Federal Leadership in Environmental, Energy, and Economic Performance
5. MPD 8500.1, MSFC Environmental Management Policy
6. MPR 8500.1, MSFC Environmental Management Program
7. MPR 8500.2, MSFC Environmental Management System
8. Steel Structures Painting Council (SSPC):

   a. SSPC Technology Guide No. 6 (2004) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations

1.3 SUBMITTALS

A. Submit one copy of Safety Data Sheets (SDS) and Chemical Inventory Worksheet for all hazardous materials brought on site. The contractor shall use MSFC Form 4582 provided by the Government.

B. Inspection Reports: Monthly Submittals (by the 10th for the previous month):

C. Construction Best Management Practices Plan (CBMPP)

1. For construction disturbances less than 1 acre, submit a Site Specific CBMPP using attachment A.
2. For construction disturbances of one acre or greater, the contractor shall obtain a Construction Storm Water Notice of Registration (NOR) on Alabama Department of Environmental Management (ADEM) Form 498. (http://www.adem.state.al (ADEM Forms). The contractor shall prepare and submit the NOR along with a CBMPP to ADEM, and have an approval from MSFC AS10 prior to starting work. Submit within 10 days of receipt a copy of any and all appropriate permits and notices received or granted.

D. Closeout Submittals

1. Submit Stormwater Inspection Records (monthly and daily inspections) at the end of the project.
2. Green Purchasing Report: The contractor shall submit a report listing purchases of items containing recycled or biobased materials on MSFC Form 4510 (MSFC Construction Green Purchasing Reporting Form). The contractor shall include the amount spent on items containing recycled materials or biobased products and amount spent on items that do not contain recycled materials or are not biobased. The accounting shall include the amount spent on all products that meet the EPA (http://www.epa.gov/epaoswer/non-hw/procure/products.htm) guidelines or the USDA guidelines (http://www.biopreferred.gov/ProposedAndFinalItemDesignations.aspx) whether specified or not.

1.4 DEFINITIONS

A. Construction disturbance: Defined in ADEM Regulation 335-6-12-.02 (e).

B. Environmental Policy: "Enabling NASA's mission by providing environmental compliance and stewardship and a safe and healthful workplace."

C. Inspection: Examining satellite accumulation points to ensure compliance with the State of Alabama Regulations. Examining site conditions, records, and plans for compliance.

D. Postconsumer content: A material or finished product that has served its intended use and has been diverted or recovered from waste destined for disposal, having completed its life as a consumer item. Postconsumer materials are part of the broader category of recovered materials.

E. Qualified Credentialed Inspector (QCI) is an operator, operator employee, or operator designated qualified person who has successfully completed initial training and annual refresher Qualified Credentialed Inspection Program (QCIP) training and holds a valid certification from an ADEM approved cooperating training entity.

F. Qualified Credential Professional (QCP) is any staff member of ADEM designated by the Director, a Professional Engineer, an Alabama Natural Resources Conservation Service professional designated by the State Conservationist, or a Certified Professional in Erosion and Sediment Control (CPESC). A QCP includes a registered landscape architect, a registered land surveyor, a Professional Geologist, a registered forester, a Registered Environmental Manager as determined by the National Registry of Environmental Professionals (NREP), and a Certified Professional Soil Scientist (CPSSc) and other ADEM accepted professional designations, certifications, and/or accredited university programs that can document requirements regarding proven training, relevant experience, and continuing education that enable recognized individuals to prepare Construction Best Management Practice Plans (CBMPPs), to make sound professional judgments regarding Alabama National Pollutant Discharge Elimination System (NPDES) rules, planning, design, implementation, maintenance, and inspection of construction sites, receiving waters, Best Management Practices (BMPs), remediation/cleanup of accumulated offsite pollutants from the regulated site, and

reclamation or effective storm water quality remediation of construction associated land disturbances, that meet or exceed recognized technical standard and guidelines, and effective industry standard practice. The QCP shall be in good standing with the authority granting the registration or designation.

G. Waste Stream: A generation of a spent/waste hazardous or recyclable material that requires either recovery or disposal in accordance with appropriate environmental, NASA, Federal, State and local laws and regulations.

1.5 EXPLOSIVE ORDNANCE AND CHEMICAL WARFARE MATERIAL PRECAUTION

A. See Section 01 05 90, 1.4.

PART 2 - PRODUCTS

2.1 ACCUMULATION CONTAINERS

A. Hazardous and controlled waste accumulation containers will be provided by the Government. The containers shall be requested by the Contractor three days in advance of the initial need date.

B. The containers will be labeled by the Government.

C. Ensure that the accumulation containers are secured such that the containers shall not be exposed to vehicular traffic.

D. Turn in the containers when ninety percent (90%) of the rated volume of each container is used for liquid waste. Containers of solid waste may be filled to hundred percent (100%).

E. At the time of turn-in, identify if a replacement container is required.

F. Ensure that hazardous and controlled waste are segregated and labeled by type in different accumulation containers.

PART 3 - EXECUTION

3.1 HAZARDOUS WASTE GENERATOR NOTIFICATION AND TRAINING.

A. The Contractor shall designate a person as point of contact (POC) and as many as two alternate people for each hazardous and controlled waste accumulation site.

B. The POCs shall be responsible for maintaining the Contractor's accumulation site in compliance with all applicable Federal, state and local laws and regulations.

C. The Contractor shall attend the first available SHE 101C, "Safety, Health, and Environmental (SHE) Program Construction Awareness" training after initiation of the

contract. The training is conducted on site by the Government at no cost to the Contractor.

D. Government personnel will inspect the accumulation site(s) to ensure compliance.

3.2 HAZARDOUS MATERIAL NOTIFICATION AND TRAINING

A. As required in Federal Standard 313, the Contractor shall submit to the Government a Chemical Inventory Worksheet listing the product names and quantities of all hazardous materials brought on site. The Contractor shall maintain a copy of this list at the job site for inspection by the Government. Copies of the Safety Data Sheets shall be readily accessible to all Contractor employees at the job site either hard copy or electronic. Contractor shall provide a copy of MSFC Form 4582.

B. The Contractor shall attend the first available SHE 101C, “Safety, Health, and Environmental (SHE) Program Construction Awareness” training after initiation of the contract. The training is conducted on site by the Government at no cost to the Contractor.

C. The Contractor shall ensure that all personnel working in the area are made aware of the chemical hazards associated with chemicals located at the jobsite.

3.3 HAZARDOUS AND CONTROLLED WASTE COLLECTION

A. The Contractor shall notify the Government of wastes being generated. The Government will determine the correct method of disposal. The Contractor shall submit MSFC Form 4072 to EEOH.

B. The following types of hazardous and controlled waste are commonly associated with construction projects; however, it is not necessarily an all-inclusive list. All wastes shall be collected and placed into accumulation containers for disposal.

1. All fluorescent light ballasts and lamps.
2. High Intensity Discharge (HID) lamps.
3. Free oil liquids and oil filters. Oil rags that are not saturated (no free liquids dripping) shall be disposed as solid waste.
4. Paint, paint thinners, adhesives, etc.
5. Sandblast material from tanks, equipment, and piping.
6. Materials used for cleaning and degreasing of equipment, tanks, and piping.
7. Paint chips from water blasting operation, scraping, sandblasting, grinding, etc. Shall be collected on a daily basis. Materials to be recycled shall be free of loose lead paint chips prior to recycling.
8. Aerosol cans.
9. Process piping system cleaning operations fluids shall be collected and disposed as directed.

C. The Contractor shall adhere to Government guidelines for inspections, collection, and turn-in of waste materials.

D. Asbestos-containing material (ACM) shall be bagged, labeled and handled in accordance with OSHA and EPA regulations and MSFC procedures per MPR 1840.4, “MSFC Asbestos Program”. The Contractor shall transport and dispose of ACM at the Redstone Arsenal Landfill (RSAL), unless otherwise approved by the Government. See Section 02 82 00 for additional information.

3.4 EMPTY CONTAINER MANAGEMENT

A. Empty hazardous material containers (5 gallons and larger) shall be turned in to the Government. The Contractor shall ensure the containers are empty using practices commonly employed to remove materials from that type of container such as pouring, pumping, and aspirating.

B. Clean and purge/triple rinse all empty containers as required by the Government.

C. Ensure bungs and/or tops are secured prior to storage/turn-in.

D. Empty containers shall not be stacked more than two high for any size container on pallets.

E. Empty containers that are damaged and will not seal shall be taped over the damaged area or turned upside down to prevent rainwater collection.

F. Empty containers shall be turned in frequently, as determined by the Government.

3.5 CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP)

A. Construction Best Management Practices Plan (Site disturbing greater than 1 acre): The Contractor shall prepare, submit, and have approved a site specific CBMPP, prior to work commencing on site. The Contractor will implement the CBMPP throughout the duration of the construction. This CBMPP must be prepared in accordance with ADEM Administrative Code 335-6-12-.21 by a QCP. If a Construction Storm Water Notice of Registration (NOR) from ADEM is required, the prime construction Contractor shall apply for the permit and advertise for a period of seven days by placing the permit application in the legal section of the local newspaper 15 days prior to starting any work at the selected site..

B. Construction Best Management Practices Plan (Site disturbing less than 1 acre): The Contractor shall prepare a Site Specific Construction Best Management Practices Plan (CBMPP) (Attachment A). The Contractor will implement the CBMPP throughout the duration of the contract.

C. Daily Stormwater Inspection Record: The Contractor shall perform daily inspections of hazardous waste containers, hazardous materials containers, empty containers, vehicles and equipment, and erosion and sediment controls. The daily inspection will be documented in a similar format as shown on MSFC Form 4524, Stormwater Inspection Record (available from the Government), or other format acceptable to the Contracting Officer. The inspection documentation will be maintained and available at the site for periodic verification of compliance by the Government and will be submitted to the

Government upon completion of construction.

1. Inspections: When no work is being conducted (e.g., weekends, holidays, etc.), no inspection is necessary. The Contractor shall ensure that the site is in compliance with the CBMPP. If the project construction site is greater than 1 acre, inspections shall be performed by a contractor representative that meets the requirements outlined in ADEM Administrative Codes 335-6-12-.02(p) and (q), which states that inspections must be conducted by a QCI or QCP or a person under the direct supervision of a QCP (QCP designee).

2. Daily Stormwater Prevention Inspection. The Contractor shall inspect daily, unless otherwise noted, hazardous waste containers, hazardous material containers, empty containers, vehicles and equipment, and erosion and sediment controls for:

    a. Containers protected from traffic
    b. Containers labeled
    c. Storage area neat and orderly
    d. Spillage from material handling
    e. Containers sealed, during inactivity
    f. Damaged pallets
    g. Damaged containers
    h. Spill cleanup materials available
    i. Containment system in good condition
    j. Containment valves closed
    k. Containment system water managed appropriately
    l. Fluids leaking from vehicles and equipment
    m. Containers are stacked no more than two high

D. Monthly Stormwater Inspection Record

1. The Contractor shall perform monthly inspection of erosion and sediment controls for the construction site. The inspection shall be documented in a format acceptable to the Contracting Officer. The inspection documentation shall be maintained and available at the site for periodic verification of compliance by the Government and shall be submitted to the Government upon completion of construction.

2. The Contractor shall inspect erosion and sediment controls for:

    a. No signs of excessive erosion
    b. Erosion controls are effective and in good condition
    c. No sediment buildup in storm water structures (inlets, ditches)

E. Deficiencies and Inspections: Contractor shall take immediate action to correct any environmental findings or non-compliances. Failure to come into compliance or correct a finding to the satisfaction of the contracting officer within 48 hours, from the time when the non-compliance was discovered by the contractor or from the time when the contractor was notified, shall result in the contractor stopping all on-site work at the contractor's sole expense until compliance is achieved as determined by the government and the contracting officer has approved continuation of work. The contractor may submit

to the Contracting Officer's Representative (COR) for approval within the 48 hours an Environmental Recovery Plan detailing day-by-day activities including intermediate protective measures that will be taken in order to come into compliance within a specified recovery period and to forego the stop of work until completion of the approved recovery period.

F. Stockpiles of dirt must be stabilized with temporary or permanent vegetative cover if material is not actively disturbed more than thirteen (13) days per ADEM Admin R. Code 335-6-12-.21(2)5.

3.6 SPILLS OF HAZARDOUS MATERIALS

A. The Contractor shall activate the MSFC Emergency Plan for emergency spills by dialing 911. The contractor may dial 256-544-4357 for non-emergency hazardous material spills that cannot be cleaned up with contractor cleanup material. The Contractor is responsible for costs incurred in cleaning up spills.

B. The Government will determine the correct disposal method for spilled materials.

C. The Contractor shall maintain spill cleanup material for the type of hazardous materials used at the construction site.

3.7 HANDLING, DUST CONTROL, AND DISPOSITION OF LEAD COATINGS

A. Lead-containing material shall be bagged, labeled, and handled in accordance with OSHA and EPA regulations and MSFC procedures per MWI 1840.1, "MSFC Industrial Hygiene Programs". The Contractor shall transport and dispose of lead-containing material. See Section 02 83 00 for additional information.

3.8 REQUIREMENTS FOR REMOVING LEAD COATINGS - SMALL SCALE / SHORT DURATION

A. Lead-containing material shall be bagged, labeled, and handled in accordance with OSHA and EPA regulations and MSFC procedures per MWI 1840.1, "MSFC Industrial Hygiene Programs". The Contractor shall transport and dispose of lead-containing material. See Section 02 83 00 for additional information.

3.9 GREEN PURCHASING

A. The Resource Conservation and Recovery Act (RCRA) requires that use of recovered/recycled (recycled) materials in the products to the greatest extent practicable. Additionally, Executive Order 13423 requires (1) the reduced use of chemicals and toxic materials and purchase of lower risk chemicals and toxic materials as well as (2) the expanded purchasing of environmentally sound goods and services, including biobased products. Furthermore, Executive Order 13514 requires that 95% of new contract actions are energy-efficient, biobased, environmentally preferable, non-ozone depleting, contain recycled content, or are non-toxic or less toxic. The Farm

Security and Rural Investment Act of 2002 (Farm Bill) requires the purchase and use of biobased products.

B. The Contractor shall determine from the technical specifications what products require recycled biobased content and purchase accordingly.

C. Whenever a product is required to contain recycled material or be biobased by the technical specification but cannot be produced as specified, the Contractor shall notify the COR, by submitting a product substitution request per the Section 01 60 00 entitled "Product Requirements" with a Contractor-signed letter explaining in detail what suppliers and manufactures were contacted and why the product cannot be produced as specified.

D. Green Purchasing Report: See Section 1.3 D for requirements

E. GREEN PURCHASING WAIVER: The Contractor purchase from the list of products (see Section 1.3 D) if one of the following exceptions applies: 1) Inadequate competition; 2) Unreasonable price; 3) Lack of quality/performance specifications or standards; or 4) Unavailable within a reasonable timeframe.

1. The Contractor shall prepare a request for waiver using MSFC Form 4412, "Green Purchasing Request for Waiver". Include any necessary accompanying documentation, and forward the document to the Government for concurrence and approval (follow instructions on the form). If the waiver is approved, the excepted item is available for purchase. The Government shall keep the original signed waiver. If the waiver is disapproved, the Contractor shall revise the purchase request to include the environmentally preferable product. If a disapproved waiver is disputed, the Contractor shall consult the Office of Center Operations management for resolution. If necessary, the Agency Environmental Executive shall be consulted (per NPR 8530.1) to resolve the waiver dispute.

3.10 ENVIRONMENTAL MANAGEMENT SYSTEM REQUIREMENTS

A. The Contractor shall comply with the MSFC Environmental Management Policy in MPD 8500.1 and procedures and requirements including, but not limited to, MPR 8500.1, "MSFC Environmental Management Program" and MPR 8500.2, "MSFC Environmental Management System."

B. The Contractor shall ensure that their offsite employees and subcontractors (through subcontract requirements or other means) with onsite access are aware of any environmental responsibilities associated with their activities onsite. Failure to comply with environmental policies and procedures may result in damage to the environment and could potentially result in regulatory penalties against NASA and/or the Contractor, and Contractor loss of access to NASA/Marshall facilities.

3.11 CLERCLA SITE ACCESS

A. Any Activity in the ditches surrounding Building 4473 requires a CERCLA Site Access Control Checklist, MSFC Form 4464F.

ATTACHMENT A

CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP)
(For sites disturbing less than 1 acre)

Contract Information

Contractor: _____

Address: _____

Phone: _____

Construction Site Contact Name: _____

Construction Contract Number: NNM_____

General Information: Describe the planned construction project. Include a description of amount of disturbed land, expected duration, and location. Provide a site map or use the site map included on the design drawings detailing the construction site including general drainage areas and gradients, nearby landmarks (buildings, paved areas, etc.), erosion control measures, topography.

_____

_____

_____

_____

_____

Construction Materials: Provide a general list of the types of chemicals, substances that will be used at the construction site.

_____

_____

_____

Erosion and Sediment Controls: Describe any erosion and sediment controls necessary. These controls shall be implemented during the construction period to prevent or control the loss of soil from the construction site. The methods could incorporate structural practices and/or vegetative stabilization. Examples are mulching, checkdams, temporary downdrain structures, sediment barriers, etc.

_____

_____

_____

_____

END OF SECTION

SECTION 01 24 04 - PRECONSTRUCTION SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section identifies the documents required to be submitted and approved prior to the Pre-Construction Conference.

1. Safety and Health Plan shall be submitted in accordance with Section 01 33 00 "Submittals" and Section 01 06 10 in sufficient detail to shown full compliance with the contract documents.
2. Quality Control Plan shall be submitted in accordance with Section 01 33 00 "Submittals" and Section 01 40 00 in sufficient detail to shown full compliance with the contract documents.

B. This Section identifies the documents required to be submitted at the Pre-Construction Conference.

1. Subcontractor List shall be submitted and shall conform to the requirements in Part 2 below.
2. Waste Management Plan shall be submitted in accordance with Section 01 74 19 "Construction Waste management and Disposal".

1.2 SUBMITTALS

A. Subcontract List: Submit three copies and a CD containing an electronic copy of the subcontract list at the Preconstruction Conference

PART 2 - PRODUCTS

2.1 SUBCONTRACTOR LIST

A. Submit a list of subcontractors identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Use CSI Form 1.5A or similar form and include the following information in tabular form:

B. Company name, address, telephone numbers (including cell phone numbers) for all key personnel and the business owner, point of contact and email of entity performing subcontract or supplying products.

1. Number and title of related Specification Section(s) covered by subcontract.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00 — PROJECT SCHEDULES

PART 1 - GENERAL

1.1 SUMMARY

1.2 This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work. Upon contract award, the Contractor shall begin preparation of the Contractor's construction schedule, and critical path submittals necessary to meet the Contractor's construction schedule.

1.3 DEFINITIONS

A. Critical Path: The longest continuous chain of activities through the network schedule that establishes the minimum overall Project duration and contains the least float.

B. Float: The measure of leeway in starting and completing an activity.

1.4 SUBMITTALS

A. Contractor's Baseline Construction Schedule: The Contractor's construction schedule consists of a bar chart identifying the start and finish for all tasks shown in the schedule. When NTP is given, the Contractor shall submit within 30 calendar days of the NTP, a "baseline schedule" changing only the projected NTP date to the actual NTP date on the initial schedule. Subsequent construction schedules shall be submitted every 30 calendar days thereafter, and be chronologically labeled starting with the letter "A". Submit three (3) paper copies and a CD containing the electronic file compatible with "Microsoft Project".

B. Monthly Schedule Updates. The Contractor shall update the previously approved schedule monthly and submit three (3) paper copies and a CD containing the electronic file compatible with "Microsoft Project". Each update shall include a complete revision of all activities and milestones and other and data as needed. Redlined updates will only be acceptable at the weekly meetings. As a minimum, each update shall include revised dates for the following:

1. All tasks started or completed.
2. All tasks with missed start or finish dates.
3. Milestones completed, or missed.
4. Revised percent complete for all active tasks.
5. Revised submittal dates for all submittals
6. Approved changes.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. The Contractor's construction schedule consists of a bar chart identifying the various tasks to be accomplished. Task relationships with predecessors and successors shall be included in the bar chart. Prepare the schedule to ensure consistency of the tasks with each other, the submittals schedule, payment requests, and other required schedules and reports. The schedule shall reflect construction site activities and supporting activities, such as submittal reviews, major material orders and delivery, fabrication, user activities and key milestones, etc., as well as activities at the request of the Contracting Officer.

B. Bar Chart: The Contractor shall:

1. Use a recognized computer software program to prepare the schedule.
2. Prepare the schedule in the form of a bar chart utilizing a format acceptable to the Contracting Officer.
3. Prepare a schedule with sufficient detail to facilitate the Contractor's control of the job and to allow the Contracting Officer to readily follow progress of all portions of the work.
4. Depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished.
5. Indicate project activities beginning with contract award through actual project close out date, in an organized, logical, and consistent order.
6. Show activities by major headings for primary work activities. Each major heading shall show all activities. All activities shall be shown in sufficient detail to track the progress of the task. Typically, activities shall have durations of 30 work days or less. All activities and milestones shall have at least one predecessor and/or one successor activity and/or milestone.
7. The critical path shall be clearly delineated on the display. When milestone dates are included in the Contract they shall be clearly indicated on the display.
8. As a minimum, the following detailed activities and milestones shall be included:

    a. Milestones: Contract Award, NTP, field work, phased work start and finish, final inspection, project planned completion, contract completion date.
    b. Specific activities: Bonding. Mobilization, Demobilization, Punch-list, Cleanup, and Final close out submittals.
    c. Specific project on-site construction tasks of all activities.
    d. Specific off-site tasks necessary to achieve specific project site activities.
    e. All utility outages and road crossings/closures.
    f. Submittal review activity by the Government, as specified herein and its subparagraphs, for each submittal required. Furthermore, each of these activities shall be linked as a predecessor to all affected tasks.
    g. Major equipment and material procurement including delivery (submittal handling shall be separate per above).
    h. Contract required notices to the Government which affect any task/activity (show as a one-day duration) and shall be entitled "Notice," followed by a brief description.

9. Each line item will show the scheduled percentage complete for that given contract performance period.
10. The estimated cost for each activity on the chart.

PART 3 - EXECUTION

3.1 SCHEDULING AND DETERMINATION OF PROGRESS

A. Independent of partial payments made pursuant to Standard Form 1422, Section I (Payments Under Fixed-Price Construction Contracts), Provision No. 52.232-5, there shall be no payment to exceed 90 percent of the actual cost of materials or equipment that is not installed and no partial payments will be made for materials or equipment not on site. The effort shown toward installation of this equipment will be considered by the Contracting Officer in determining the amount of partial payment.

B. As-Built Drawings: In order to minimize the time for final payment at the completion of the project, the Contractor shall update the as-built drawings every month with the Contracting Officer's authorized representative. This update will be a part of "the monthly request for payment" and payment -- or a portion of the payment, including final payment -- may be withheld until the as-built drawings have been updated, and accepted by the Contracting Officer.

3.2 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Bar Chart: The bar chart will be utilized for progress payments.

B. Construction Schedule Approval: Government approval of the construction schedule is in general terms of overall compliance. The Government may question and seek clarification of certain details of the schedule to ensure contract compliance. The Contractor shall make such clarifications within 5 working days. The Contractor retains full responsibility for creation and maintenance of the schedule as well as its contents, logic, and use to fulfill all contract obligations.

C. Requests for Time Extensions: In the event the Contractor requests an extension of the contract completion date, he shall furnish a justification for delay, a revised project completion date, and supporting evidence as the Contracting Officer may deem necessary for a determination as to whether or not the Contractor is entitled to an extension of time under the provisions of the contract. Submission of proof of delay, based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is obligatory to any approvals.

1. Justification for Delay: The Contractor shall submit a justification for each request for a change in the contract completion date, based upon the most recent approved schedule at the time of the Notice to Proceed or constructive direction issued for the change. The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

a. A list of affected activities, with their associated project schedule activity number.
b. A brief explanation of the causes of the change.
c. An analysis of the overall impact of the changes proposed.
d. A sub-network of the affected area.
e. Activities impacted in each justification for change shall be identified by a unique activity code contained in the required data file.

The Contracting Officer's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in the extension of the schedule, will not be a cause for a time extension to the contract completion date.

D. Directed Changes: If Notice to Proceed (NTP) is issued for changes prior to settlement of price and/or time, the Contractor shall submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The proposed revisions to the schedule will be approved by the Contracting Officer prior to inclusion of those changes within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until revisions are submitted and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, the Contractor shall advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work. All logic changes pertaining to notice to proceed on change orders, change orders to be incorporated into the schedule, Contractor proposed changes in work reference, correction to schedule logic for out-of-sequence progress, lag duration, and other changes that have been made pursuant to contract provisions shall be specifically identified and discussed.

E. Float off the critical path may be used at the Contractor’s discretion. However, use of float on the critical path shall be coordinated with the Government at each weekly project meeting. The Government reserves the right to utilize at its discretion use of float created by the Government acceleration of activities or milestones such as early GFE delivery, use of facilities or space, and early submittal review.

END OF SECTION

SECTION 01 33 00 — SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for all project submittals required by the individual Specification Sections.

PART 2 - PRODUCTS

2.1 SUBMITTALS

A. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents.

1. Drawing Preparation: Include the following information, as applicable:

a. The job name, which shall be the general title of the contract drawings.
b. The date of the drawings and revisions.
c. Name of Contractor.
d. Name of Subcontractor.
e. The name of the item, material, or equipment detailed thereon.
f. Dimensions.
g. Identification of products.
h. Fabrication and installation drawings.
i. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
j. Shopwork manufacturing instructions.
k. Templates and patterns.
l. Schedules.
m. Design calculations.
n. Compliance with specified standards.
o. Notation of coordination requirements.
p. Notation of dimensions established by field measurement.

2. Drawing Format: Drawing submittals shall be prepared using computer interactive graphics and presented on sheets, not less than 11 by 17 inches nor larger than 30 by 42 inches in size, except for full size patterns or templates. Drawings shall be prepared to accurate size, with scale indicated, unless other form is required. Drawings shall have dark lines on a white background. Drawings shall be numbered in logical sequence. The Contractor may use his own number system. Each drawing set shall contain identification of the transmittal number, specification section or contract number or title. A blank space, no smaller than

4 inches by 4 inches, shall be reserved on the right hand side of each sheet for the Government disposition stamp.

3. Drawings Submittals: Five prints of each drawing shall be submitted. Three prints, marked with review notations will be returned to the Contractor.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.

1. Product Data Preparation: Include the following information, as applicable:

a. Manufacturer's product specifications.
b. Standard color charts.
c. Manufacturer's catalog cuts.
d. Wiring diagrams showing factory-installed wiring.
e. Printed performance curves.
f. Operational range diagrams.
g. Mill reports.
h. Standard product operating and maintenance manuals.
i. Compliance with recognized trade association standards.
j. Compliance with recognized testing agency standards.
k. Application of testing agency labels and seals.
l. Notation of coordination requirements.
m. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:

1) Preparation of substrates.
2) Required substrate tolerances.
3) Sequence of installation or erection.
4) Required installation tolerances.
5) Required adjustments.
6) Periodic maintenance requirements
7) Recommendations for cleaning and protection.

2. Product Data Format: Required data submittals for each specific material, product, unit of work, or system shall be collected on an individual submittal and marked for choices, options, and portions applicable to the submittal. Mark each copy of each submittal to show which products and options are applicable. All options not marked out shall be considered as included. Marking of each copy of product data submitted shall be identical. Partial submittals will not be accepted.

3. Each Product Data Submittal: Five complete sets of indexed and bound data shall be submitted. Three sets marked with review notations will be returned to the Contractor.

C. Samples: Prepare physical units of materials or products, including the following:

1. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

2. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

3. Sample Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Government's sample where so indicated. Attach label on unexposed side that includes the following:

    a. Name of project
    b. Name of Contractor
    c. Material or equipment
    d. Place of origin
    e. Name of producer and brand
    f. Specification Section to which sample applies
    g. Samples of furnished material shall have additional markings that will identify them under the finished schedules.

4. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:

    a. Size limitations.
    b. Compliance with recognized standards.
    c. Availability.
    d. Delivery time.

5. Samples Format: Samples shall be physically identical with the proposed material or product to be incorporated in the work, fully fabricated and finished in the specified manner, and full scale. Where variations in color, finish, pattern, or texture are inherent in the material or product represented by the sample, multiple units of the sample, showing the near-limits of the variations and the "average" of the whole range (not less than 3 units), shall be submitted. Each unit shall be marked to describe its relation to the range of the variation. Where samples are specified for selection of color, finish, pattern, or texture, the full set of available choices shall be submitted for the material or product specified. Sizes and quantities of samples shall represent their respective standard unit.

6. Sample Submittals: One set of identified samples shall be submitted. Shipping charges shall be paid by the Contractor. Materials or equipment requiring sample approval shall not be delivered to the site or used in the work until approved in writing by the Contracting Officer. A copy of the transmittal form, marked with review notations including selections by the Contracting Officer, will be returned to

the Contractor. Samples that are intended or permitted to be returned and actually incorporated in the work are so indicated in the individual technical sections. These samples will be returned to the Contractor, at his expense, to be clearly labeled, with installation location recorded. Samples shall be in undamaged condition at the time of installation. Where mockups and similar large samples are required by individual technical sections, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Otherwise, and except as indicated in the individual technical sections, the requirements for samples shall be complied with and a transmittal form shall be processed for each mockup, to provide a record of the activity.

D. Coordination Drawings: Contractor to submit to COR for approval coordination drawings of all ductwork, including equipment rooms, shafts, hallways, and especially congested areas and areas with possible conflicts. No installation shall proceed without COR stamped approval of coordination drawings. Submittal to reflect space requirements coordinated with other trades such as Electrical, Plumbing, Mechanical and Structural. Prior to submission to COR, coordination drawings to have signatory approval of all major trades which occupy ceiling space (HVAC, plumbing, piping, sprinkler, and electrical), to substantiate adequate coordination as to space, accessibility and to ensure no conflict exists between contractors.

1. Indicate relationship of components shown on separate Shop Drawings.
2. Indicate required installation sequences.
3. The General Contractor shall be responsible for coordination between trades and shall stamp and sign the duct drawings to substantiate that the coordination has been accomplished. Water piping and conduit shall give way to ducts.

E. Product Schedule or List: Prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product.
2. Number and name of room or space.
3. Location within room or space.

F. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

G. Contractor’s Construction Schedule: Comply with requirements in Section 01 32 00 "Project Schedules."

H. Submittals Schedule: Comply with requirements in Specification Section "01 24 04."

I. Subcontract List: Comply with requirements Specification Section "01 24 04"

J. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

K. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.

L. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

M. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

N. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

O. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

P. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements. Reports must be signed by authorized representative of the testing agency.

Q. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements. Reports must be signed by authorized representative of the testing agency.

R. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion. Reports must be signed by authorized representative of the testing agency.

S. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements. Reports must be signed by authorized representative of the testing agency.

T. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests

performed by a qualified testing agency. Reports must be signed by authorized representative of the testing agency.

U. Factory Test Reports: Prepare written reports of tests performed by the manufacturer as indicated in individual Specification Sections

V. Operations and Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 1 Section "Closeout Procedures" and "Operation and Maintenance Data."

W. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

X. Warranties: Provide Manufacturer's warranty as indicated in individual Specification Sections

Y. Product Closeout Submittals Comply with requirements in Division 1 Section "Closeout Procedures"

PART 3 - EXECUTION

3.1 CONTRACTOR

A. All submittals shall be verified for compliance with the Contract Documents and signed by the contractor.

B. No work may begin or materials be ordered for any item, until a submittal is approved and returned to the contractor.

3.2 SUBMITTAL REQUIREMENTS

A. Each submittal shall reference drawing number, Specification Section and paragraph pertaining to the submittal and fully describe the submittal item.

B. The numbering system used (on the transmittal form) for transmission and tracking of submittals shall be provided by the Government and used by the Contractor. The submittal number is composed of the Specification Section number followed by a hyphen, and the numerical order of each submission beginning with 001. Revisions and resubmittals will be numbered chronologically thereafter.

C. Transmittal Form: All transmittals submitted to the Government shall be submitted using MSFC Form 4233. All data fields on the form shall be completed and the form signed by the Contractor. Incomplete submittals will be returned to the Contractor without Government review. Each transmittal form shall transmit items relative to one Specification Section. Data pertaining to that Specification Section may be transmitted together, unless required to be submitted as an individual "item." An item is an individual piece recognized by the type of data being submitted. Examples in general of acceptable individual submittal transmittals include:

1. Groups of valves of different sizes. A submittal would allow that all of the information pertaining to those valves could be listed and submitted on one submittal transmittal.
2. Structural drawings and calculations for individual structures.
3. Electrical lighting troffers, ballast, bulbs, and lenses along with installation instructions and certificates of compliance.
4. Air handlers of the same type.
5. Submittals can list one individual piece pertaining to specific data, such as one valve on one submittal and one instruction manual on another, etc.

D. Product Selection: Highlight, circle, or otherwise identify the specific item selected for use on the project. Include manufacturer, model, size (where applicable) and options.

E. Deviations: Deviations from the specific product options in the Contract Documents shall be highlighted, circled, or otherwise identified on submittals. Failure to point out deviations may result in the Government rejection and requiring removal of such work at no additional cost to the Government.

F. Substitutions: Indicate if product is a substitution and comply with Specification Section 01 60 00. Failure to point out substitutions may result in the Government rejection and requiring removal of such work at no additional cost to the Government

G. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. The Government reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

H. Submittal Quantities: Submit five copies of all submittals unless directed otherwise by the COR.

3.3 GOVERNMENT'S REVIEW

A. General: The Government will not review submittals that do not bear Contractor's signature and will return them without action. The Government will review submittals and provide pertinent notation within 28 calendar days. The 28-day review clock shall start the day after submittals are received by the Government.

1. Approved Submittals: Approval of the submittals by the Contracting Officer shall not be construed as a complete check but will indicate only that the general method of construction and detailing is satisfactory. The Contractor shall be responsible for the dimensions and design of connection details and construction of work. If changes are necessary to approved submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change shall be accomplished until the changed submittals are approved

2. Resubmittals: For submittals requiring resubmittal, the Contractor shall make corrections required by the Contracting Officer and resubmit within 14 calendar days of receipt. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or Specifications, notice as required under the clause entitled "Changes" shall be given to the Contracting Officer.

B. Review Notations: Submittals will be returned to the Contractor with the following notations:

1. Submittals marked "Approved (APR)" authorize the Contractor to proceed with the work covered.
2. Submittals marked "Approved as Noted (AAN)" authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections.
3. Submittals marked "Approved Except as Noted (AEN)" require the Contractor to make a resubmittal for those items that are noted to NOT be in compliance with the contract requirements. Contractor shall obtain an approval for all aspects of the submittal before the depicted work can begin.
4. Submittals marked "Rejected (REJ)" indicate noncompliance with the contract requirements and shall be resubmitted with appropriate changes prior to proceeding with any work. .

C. Sample Approval: The Contractor shall furnish, for the approval of the Contracting Officer, samples required by the Specifications or by the Contracting Officer.

1. Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify any contract requirements. Before submitting samples, the Contractor shall assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

2. Materials and equipment incorporated in the work shall match the approved samples. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of

the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

3. Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make of that material. The Government reserves the right to disapprove any material or equipment which previously has proved unsatisfactory in service.

4. Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. The Contractor shall replace such materials or equipment to meet contract requirements.

5. Approval of the Contractor's samples by the Contracting Officer shall not relieve the Contractor of his responsibilities under the contract.

END OF SECTION

SECTION 01 40 00 — CONTRACTOR QUALITY ASSURANCE/QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This specification sets forth quality assurance/quality control requirements for the provision of materials, equipment, systems, inspections, tests, services, and construction of facilities and site improvements. The quality of work-in-progress and finished work is the responsibility of Contractor line management. These requirements provide for an effective system to ensure that contractual quality requirements and technical criteria are satisfactorily met.

1.2 RELATION TO OTHER CONTRACT DOCUMENTS

A. The requirements of this specification shall be fully complied with in close concert with the detail requirements of the technical specifications and all other contract documents. Overlapping and interfacing contractual requirements shall not result in duplication of Contractor efforts. The quality program shall effectively complement and support functions required by the technical specifications and other contract documents.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

A. Preconstruction Submittals: The Contractor shall submit a detailed written “Contractor’s Quality Assurance/Quality Control Plan” describing procedures that will be implemented to achieve quality on the project. The plan shall be submitted and approved by the Government prior to Notice to Proceed and describe how the quality requirements of the specifications will be met and address each of the following:

1. Delegation of Contractor's authorized representative responsible for quality assurance/control of contract work.
2. The Contractor's quality assurance/control plan and procedure for accomplishing and reviewing construction methods and controls, fabrication controls, certifications, documentation of quality control operations, inspections, and test records including those required for suppliers and subcontractors. Describe methods to be effected during the procurement cycle (order to deliver) for the selection of construction materials, suppliers, subcontractors, on-site and off-site fabrication and assembly of Contractor- furnished materials and equipment, work procedures, workmanship, and testing to ensure full compliance with plans, specifications, codes, regulatory requirements, and other contract documents.
3. The Contractor's program shall provide for a functional system to document that quality provisions of contract schedules, specifications, and drawings have been performed.

4. Training, certification(s), and re-certification(s) of personnel as required by the specifications.
5. Certification of materials, processes, or equipment as required by the specifications.
6. Qualification of procedures as required by the specifications.
7. Nondestructive testing requirements as required by the specifications.
8. Identification of independent certifying and testing laboratories to be used.

B. Records: Records shall include all quality control data; factory test plans/results, manufacturer's certifications, receiving inspections, deficiency correction reports; construction deficiency reports (CDR); training/certifications; letter of authority or delegation; and routine technical test plans/results, i.e., hydrostatic, electrical continuity, grounding, welding, line cleaning, etc. Quality records shall be available for examination upon request by the designated Government representatives. Quality control records shall be maintained in a central on-site location. Maintenance of quality control records shall not relieve the Contractor from submitting samples, test data, detail drawings, material certificates, or other information required by each section in the specification. All quality records shall be turned over to the Government's designated representatives as a file of record at contract completion.

1.4 QUALITY ASSURANCE

A. Qualifications: When approval or certification of special processes, operating personnel, and special equipment or procedures is required by the specifications, the Contractor shall obtain necessary approvals or certifications prior to starting the work.

B. Management and Organization: Contractor shall ensure effective execution of quality assurance/quality control functions and provide competent personnel with experience in quality assurance/quality control functions to provide supervision, inspection, and testing. Contractor shall be responsible for each of his suppliers and subcontractors. Contractor shall provide quality assurance oversight of suppliers and subcontractors and ensure that each provides effective quality control in the execution of their work. The program shall encompass management and supervisory actions that affect quality of all work-in-progress and finished construction work. The individual designated to direct the program shall report to the Contractor's management and shall have the necessary authority to discharge his responsibilities.

C. Identification and Data Retrieval: The Contractor shall have an identification and data retrieval system. Records, drawings, submittals, and equipment shall be identified to reference the following:

1. Contract Number
2. Contract Specification Number
3. Contract Drawing Number
4. Submittal Document Number
5. Contract Change Number
6. Contractor's Drawing Number System

D. Procurement: The Contractor shall be responsible for controlling procurement sources and those of his subcontractors to ensure that each purchase meets quality requirements. The Contractor shall ensure that his purchase documents include:

1. The basic quality requirements, standards, drawings, and specifications called out in the contract specifications.
2. Inspection and Test Characteristics.
3. Inspection and Test Records.
4. Operational and Maintenance (O&M) manuals, Instructions, Certifications of Compliance, and such other data as may be required by the specification.
5. Preservation, packaging, shipping directions.

E. When Government source inspection is required on a Contractor's purchase, the purchase document shall include the following statement: “All work on this order is subject to inspection and testing by the Government at any time and place. The Contracting Officer shall be notified immediately upon receipt of this order. The Contracting Officer shall be notified 72 hours in advance of the time articles or processes are ready for inspection or test."

F. Procurements that do not require Government source inspection shall include the following statement: "The Government reserves the right to inspect any or all of the materials included on this order at the Contractor's plant."

G. Required Government source inspections will be determined by the Contracting Officer. Government source inspections shall not replace Contractor inspections or relieve the Contractor of his responsibility for ensuring quality procurements and records verifying quality control activities.

H. Receiving Inspection System: Contractor shall maintain a receiving inspection system that ensures procured materials and equipment are inspected and tested as required by specifications, drawings, and approved submittal documents. Shipping/receiving inspection records will accompany each procurement delivery to the construction site. Maintain records of receiving inspections at the construction site by the Contractor. Records shall show defects, discrepancies, dispositions, and waivers, including evidence of Government source inspection.

I. Nonconforming Articles and Material Control: The Contractor shall control nonconformances discovered by the Contractor, subcontractors, suppliers or Government quality representatives to prevent their use and to correct deficient operations.

1. Contractor shall prepare a construction deficiency report for each instance comprising:

   a. A unique and traceable number.
   b. Identification of the nonconforming article or material.
   c. A description of the nonconformance and the applicable requirement.
   d. Cause or reason for the nonconformance.
   e. Remedial actions taken or recommended.
   f. Disposition of the nonconforming article or material.

2. The Contractor shall identify, mark, and segregate each nonconforming article for removal from the work area to prevent inadvertent use.
3. The Contractor shall monitor and correct deficient operations.

J. Fabrication, Process, and Work Control: The Contractor's procedures and controls shall be derived from stated requirements in contract specifications and drawings. The Contractor shall establish in-process inspections and ensure compliance with quality requirements that are not readily detectable or measurable by inspection and test of finished elements. Special processes may include, but are not limited to, concrete placement, piping system cleaning, plating, anodizing, nondestructive testing, welding, and soldering.

K. Drawings and Change Control: Drawing-control system shall be maintained to provide revised drawings and change distribution and removal of obsolete drawings from work areas. Changes involving interface with other work areas, or affecting articles or materials controlled by others shall be controlled by the Contractor. This system shall be integrated with the document requirements of the contract. Drawing changes shall be clearly specified. Accomplished changes shall be clearly identified and associated drawings shall be revised. Drawings that have been approved, or approved as noted, by the Contracting Officer shall be used for fabrication and inspection.

L. Quality Inspections: Government Inspections: Work performed under the general direction of the Contracting Officer will be subject to inspection by authorized representatives. No representative is permitted to change specifications or drawings without written authorization of the Contracting Officer. Government in-process and end-item inspections may, at the Government's discretion, be performed on site and/or at the Contractor's or subcontractor's facility by Government representatives. Government shall be notified with sufficient advance notice of Contractor work plans which will cover up or make inaccessible previously installed work which may require Government inspection, i.e., backfilling or encasing of any underground utility, concrete placement, etc. Failure to provide such notification may require the work be uncovered to inspect the work. Uncovering and restoration of the work shall be at the Contractor's expense. The Contractor's quality assurance/control program is subject to continuous evaluation, review, and verification by the Contracting Officer. The Contractor will be notified in writing of any noncompliance area and will be given 5 days to correct identified deficiencies.

M. Contractor's Quality Inspections: Contractor shall implement an inspection system. Documentation shall indicate quality control through records of inspections and tests. Contractor shall ensure that nonconforming products are discovered, documented, and controlled. Procedures eliminating future deficiencies shall be implemented. Contractor's quality assurance system shall include the following:

1. Single Contractor's representative responsible for on-site/off-site communication and operation of the inspection program.
2. Purchasing control system documenting project procurement to drawings, specifications, and approved submittals.
3. Receiving inspection system documenting inspections for each procurement verifying material and equipment is compliant with plans and specifications.
4. Documentation for handling and disposing of nonconforming components and materials.

5. Inspection records as required for each specific section of the specification and drawings.
6. Identification of test(s) to be performed, test procedures, test plans/reports, records, and independent organizations used.
7. Documenting and maintaining certification or re-certification of procedures, personnel, and equipment.
8. Management of Government-furnished equipment, components, and materials.
9. Calibration of gages, tools, measuring instruments, and independent laboratories used and all associated documentation.

N. The Contractor shall establish his own system of scheduled or random sample inspections and audits to ensure objectives are met.

O. Manufacturer's Field Services: Responsibility for Inspection and Testing: Contractor is responsible for the performance of inspections and tests. Each shall be recorded. The Contractor shall utilize independent inspection and testing laboratories or services that are acceptable to the Government. Tests of construction materials shall be accomplished by the Contractor utilizing the services of an acceptable independent testing laboratory.

P. Inspection and Test Records: The Contractor shall provide on-site records of each inspection and test performed throughout the life of the contract. Records shall include, but not be limited to, factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, identification of operators and inspectors, test plans/reports, result of inspections or tests, nature of defects, causes for rejection, proposed remedial action, and corrective actions taken.

Q. Records of in-process inspections and controls away from the job site may be used as evidence of quality of materials/work and, at the discretion of the Government, may reduce further inspection or testing after delivery to the job site.

R. The Contractor shall ensure each record is identified and traceable to specific requirements in the specifications and drawings.

1.5 HANDLING AND STORAGE

A. The Contractor shall provide controls and procedures which meet requirements of each section of the specifications. The Contractor shall include documentation with each shipment. The data shall consist of documentation required by the contract along with specifications required to identify, store, preserve, operate, and maintain the items shipped.

1.6 SEQUENCING AND SCHEDULING

A. Contractor shall notify the Government a minimum of 48 hours prior to scheduled inspections and tests. Contractor shall provide 24-hour notice to the Government of the date when the contract work will begin at the site. When Contractor suspends work

for 5 days or longer prior to completion, he shall notify the Contracting Officer. Work shall not suspend nor resume without notification of the Contracting Officer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

C. Conflicting Requirements: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the Contracting Officer for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Contracting Officer for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

E. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

ADAAG	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities Available from Access Board www.access-board.gov	 (800) 872-2253 (202) 272-5434

CFR	Code of Federal Regulations Available from Government Printing Office www.access.gpo.gov/nara/cfr	 (888) 293-6498 (202) 512-1530
CRD	Handbook for Concrete and Cement Available from Army Corps of Engineers Waterways Experiment Station www.wes.army.mil	 (601) 634-2355
DOD	Department of Defense Specifications and Standards Available from Defense Automated Printing Service //astimage.daps.dla.mil/online	 (215) 697-6257
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Defense Automated Printing Service //astimage.daps.dla.mil/online	 (215) 697-6257
	Available from General Services Administration www.fss.gsa.gov/pub/fed-specs.cfm	(202) 619-8925
	Available from National Institute of Building Sciences www.nibs.org	(202) 289-7800
FTMS	Federal Test Method Standard (See FS)	
MILSPEC	Military Specification and Standards Available from Defense Automated Printing Service //astimage.daps.dla.mil/online	 (215) 697-6257
NSS	NASA Safety Standards www.hq.nasa.gov/office/codeq/codeg/doctree/1740-9.pdf	
UFAS	Uniform Federal Accessibility Standards Available from Access Board www.access-board.gov	 (800) 872-2253 (202) 272-5434

1.2 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale Research's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association, Inc. (The) www.aluminum.org	(202) 862-5100
AAADM	American Association of Automatic Door Manufacturers www.aaadm.com	(216) 241-7333
AABC	Associated Air Balance Council www.aabchq.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AAN	American Association of Nurserymen (See ANLA)	
AASHTO	American Association of State Highway and Transportation Officials www.aashto.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists (The) www.aatcc.org	(919) 549-8141
ABMA	American Bearing Manufacturers Association www.abma-dc.org	(202) 367-1155
ACI	American Concrete Institute/ACI International www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
ADC	Air Diffusion Council www.flexibleduct.org	(312) 201-0101
AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AFPA	American Forest & Paper Association (See AF&PA)	
AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700

AGA	American Gas Association www.aga.org	(202) 824-7000
AGC	Associated General Contractors of America (The) www.agc.org	(703) 548-3118
AGMA	American Gear Manufacturer's Association www.agma.org	(703) 684-0211
AHA	American Hardboard Association www.ahardbd.org	(847) 934-8800
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AI	Asphalt Institute www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.e-architect.com	(202) 626-7300
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction www.aitc-glulam.org	(303) 792-9559
ALA	American Laminators Association (See LMA)	
ALCA	Associated Landscape Contractors of America www.alca.org	(800) 395-2522 (703) 736-9666
ALSC	American Lumber Standard Committee	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANLA	American Nursery & Landscape Association (Formerly: AAN - American Association of Nurserymen) www.anla.org	(202) 789-2900
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts www.aosaseed.com	(402) 476-3852

APA	APA - The Engineered Wood Association www.apawood.org	(253) 565-6600
APA	Architectural Precast Association www.archprecast.org	(941) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute www.ari.org	(703) 524-8800
ASCA	Architectural Spray Coaters Association www.ascassoc.com	(609) 848-6120
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (212) 591-7722
ASSE	American Society of Sanitary Engineering www.asse-plumbing.org	(440) 835-3040
ASTM	American Society for Testing and Materials www.astm.org	(610) 832-9585
AWCI	AWCI International (Association of the Wall and Ceiling Industries International) www.awci.org	(703) 534-8300
AWCMA	American Window Covering Manufacturers Association (See WCMA)	
AWI	Architectural Woodwork Institute www.awinet.org	(800) 449-8811 (703) 733-0600
AWPA	American Wood-Preservers' Association www.awpa.com	(817) 326-6300
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353

AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The) www.bia.org	(703) 620-0010
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International) www.bifma.com	(616) 285-3963
CCC	Carpet Cushion Council www.carpetcushion.org	(203) 637-1312
CCFSS	Center for Cold-Formed Steel Structures www.umr.edu/~ccfss	(573) 341-4471
CDA	Copper Development Association Inc. www.copper.org	(800) 232-3282 (212) 251-7200
CEA	Canadian Electricity Association www.canelect.ca	(613) 230-9263
CFFA	Chemical Fabrics & Film Association, Inc. www.chemicalfabricsandfilm.com	(216) 241-7333
CGA	Compressed Gas Association www.cganet.com	(703) 412-0900
CGSB	Canadian General Standards Board www.pwgsc.gc.ca/cgsb	(819) 956-0425
CIMA	Cellulose Insulation Manufacturers Association www.cellulose.org	(888) 881-2462 (937) 222-2462
CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute www.cispi.org	(423) 892-0137
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CMAA	Crane Manufacturer’s Association of America, Inc. www.mhia.org	(704) 676-1190
CPA	Composite Panel Association	(301) 670-0604

	(Formerly: National Particleboard Association) www.pbmdf.com	
CPPA	Corrugated Polyethylene Pipe Association www.cppa-info.org	(800) 510-2772 (202) 462-9607
CRI	Carpet & Rug Institute (The) www.carpet-rug.com	(800) 882-8846 (706) 278-3176
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSA	CSA International (Formerly: IAS - International Approval Services) www.csa-international.org	(800) 463-6727 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
CSSB	Cedar Shake & Shingle Bureau www.cedarbureau.org	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
EIA/TIA	Electronic Industries Alliance/Telecommunications Industry Association www.eia.org	(703) 907-7500
EIMA	EIFS Industry Members Association www.eifsfacts.com	(800) 294-3462 (770) 968-7945
EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
FCI	Fluid Controls Institute www.fluidcontrolsinstitute.org	(216) 241-7333
FGMA	Flat Glass Marketing Association (See GANA)	
FM	Factory Mutual System (See FMG)	
FMG	FM Global (Formerly: FM - Factory Mutual System)	(401) 275-3000

	www.fmglobal.com	
GA	Gypsum Association www.gypsum.org	(202) 289-5440
GANA	Glass Association of North America (Formerly: FGMA - Flat Glass Marketing Association) www.glasswebsite.com/gana	(785) 271-0208
GRI	Geosynthetic Research Institute www.drexel.edu/gri	(215) 895-2343
GTA	Glass Tempering Division of Glass Association of North America (See GANA)	
HI	Hydraulic Institute www.pumps.org	(888) 786-7744 (973) 267-9700
HI	Hydronics Institute www.gamanet.org	(908) 464-8200
HMMA	Hollow Metal Manufacturers Association (See NAAMM)	
HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAS	International Approval Services (See CSA International)	
ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(508) 394-4424
ICRI	International Concrete Repair Institute (The) www.icri.org	(703) 450-0116
IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IESNA	Illuminating Engineering Society of North America www.iesna.org	(212) 248-5000
IGCC	Insulating Glass Certification Council	(315) 646-2234

	www.igcc.org	
ILI	Indiana Limestone Institute of America, Inc. www.iliai.com	(812) 275-4426
IRI	Industrial Risk Insurers www.industrialrisk.com	(800) 243?8308 (860) 520?7300
ITS	Intertek Testing Services www.itsglobal.com	(800) 345-3851 (607) 753-6711
IWS	Insect Screening Weavers Association (Now defunct)	
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690
LGSI	Light Gage Structural Institute www.loseke.com	(972) 370-0967
LMA	Laminating Materials Association (Formerly: ALA - American Laminators Association) www.lma.org	(201) 664-2700
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864 (847) 577-7200
LSGA	Laminated Safety Glass Association (See GANA)	
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MCA	Metal Construction Association www.metalconstruction.org	(312) 201-0193
MFMA	Maple Flooring Manufacturers Association www.maplefloor.org	(847) 480-9138
MFMA	Metal Framing Manufacturers Association	(312) 644-6610
MGPHO	Medical Gas Professional Healthcare Organization, Inc. www.mgpho.org	(877) 238-5157 (913) 681-6548
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-institute.com	(614) 228-6194
ML/SFA	Metal Lath/Steel Framing Association	

	(See SSMA)	
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(312) 332-0405
NAAMM	North American Association of Mirror Manufacturers (See GANA)	
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(281) 228-6200
NAIMA	North American Insulation Manufacturers Association (The) www.naima.org	(703) 684-0084
NAMI	National Accreditation and Management Institute, Inc.	(304) 258-5100
NAPM	National Association of Photographic Manufacturers (See PIMA)	
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute www.ncpi.org	(414) 248-9094
NCTA	National Cable Television Association www.ncta.com	(202) 775-3669
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association www.necanet.org	(301) 657-3110
NeLMA	Northeastern Lumber Manufacturers' Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200

NETA	InterNational Electrical Testing Association www.netaworld.org	(303) 697-8441
NFPA	National Fire Protection Association www.nfpa.org	(800) 344-3555 (617) 770-3000
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-6372
NGA	National Glass Association www.glass.org	(703) 442-4890
NHLA	National Hardwood Lumber Association www.natlhardwood.org	(800) 933?0318 (901) 377-1818
NLGA	National Lumber Grades Authority www.nlga.org	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association www.nofma.org	(901) 526-5016
NPA	National Particleboard Association (See CPA)	
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association www.nrmca.org	(888) 846-7622 (301) 587-1400
NSA	National Stone Association www.aggregates.org	(800) 342-1415 (703) 525-8788
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
NTMA	National Terrazzo and Mosaic Association, Inc. www.ntma.com	(800) 323-9736 (703) 779-1022
NWWDA	National Wood Window and Door Association (See WDMA)	
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDCA	Painting and Decorating Contractors of America www.pdca.com	(800) 332-7322 (703) 359-0826
PDI	Plumbing & Drainage Institute	(800) 589-8956

	www.pdionline.org	(508) 230-3516
PGI	PVC Geomembrane Institute //pgi-tp.ce.uiuc.edu	(217) 333-3929
PIMA	Photographic & Imaging Manufacturers Association (Formerly: NAPM - National Association of Photographic Manufacturers) www.pima.net	(914) 698-7603
RCSC	Research Council on Structural Connections www.boltcouncil.org	(800) 644-2400 (312) 670-2400
RFCI	Resilient Floor Covering Institute (Contact by mail only)	
RIS	Redwood Inspection Service www.calredwood.org	(888) 225-7339 (415) 382-0662
RMA	Rubber Manufacturers Association www.rma.org	(800) 220-7620 (202) 682-4800
SAE	SAE International www.sae.org	(724) 776-4841
SDI	Steel Deck Institute www.sdi.org	(847) 462-1930
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010
SEFA	Scientific Equipment and Furniture Association www.sefalabfurn.com	(843) 689-6878
SGCC	Safety Glazing Certification Council www.sgcc.org	(315) 646-2234
SIGMA	Sealed Insulating Glass Manufacturers Association www.sigmaonline.org/sigma	(312) 644-6610
SJI	Steel Joist Institute www.steeljoist.org	(843) 626-1995
SMA	Screen Manufacturers Association	(561) 533-0991
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacna.org	(703) 803-2980
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics	(800) 523-6154

	Industry, Inc.; Spray Polyurethane Foam Division) www.sprayfoam.org	
SPI	The Society of the Plastics Industry www.plasticsindustry.org	(202) 974-5200
SPIB	Southern Pine Inspection Bureau (The) www.spib.org	(850) 434-2611
SPI/SPFD	The Society of the Plastics Industry Spray Polyurethane Foam Division (See SPFA)	
SPRI	SPRI (Single Ply Roofing Institute) www.spri.org	(781) 444-0242
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSMA	Steel Stud Manufacturers Association (Formerly: ML/SFA - Metal Lath/Steel Framing Association) www.ssma.com	(312) 456-5590
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(800) 837-8303 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333
SWRI	Sealant, Waterproofing, and Restoration Institute www.swrionline.org	(816) 472-7974
TCA	Tile Council of America, Inc. www.tileusa.com	(864) 646-8453
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance www.tiaonline.org	(703) 907-7700
TPI	Truss Plate Institute	(608) 833-5900
TPI	Turfgrass Producers International www.turfgrasssod.org	(800) 405-8873 (847) 705-9898

UFAC	Upholstered Furniture Action Council www.ufac.org	(336) 885-5065
UL	Underwriters Laboratories Inc. www.ul.com	(800) 704-4050 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USITT	United States Institute for Theatre Technology, Inc. www.culturenet.ca/usitt	(800) 938-7488 (315) 463-6463
USP	U.S. Pharmacopeia www.usp.org	(800) 822-8772 (301) 881-0666
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association (Formerly: AWCMA - American Window Covering Manufacturers Association) www.windowcoverings.org	(800) 506-4653 (212) 661-4261
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association) www.wdma.com	(800) 223-2301 (847) 299-5200
WIC	Woodwork Institute of California www.wicnet.org	(916) 372-9943
WMMPA	Wood Moulding & Millwork Producers Association www.wmmpa.com	(800) 550-7889 (530) 661-9591
WWPA	Western Wood Products Association www.wwpa.org	(503) 224-3930

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

BOCA	BOCA International, Inc. www.bocai.org	(708) 799-2300
CABO	Council of American Building Officials (See ICC)	

IAPMO	International Association of Plumbing and Mechanical Officials (The) www.iapmo.org	(909) 595-8449
ICBO	International Conference of Building Officials www.icbo.org	(800) 284-4406 (562) 699-0541
ICC	International Code Council (Formerly: CABO - Council of American Building Officials) www.intlcode.org	(703) 931-4533
SBCCI	Southern Building Code Congress International, Inc. www.sbcci.org	(205) 591-1853

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CE	Army Corps of Engineers www.usace.army.mil	
CPSC	Consumer Product Safety Commission www.cpsc.gov	(800) 638-2772 (301) 504-0990
DOC	Department of Commerce www.doc.gov	(202) 482-2000
EPA	Environmental Protection Agency www.epa.gov	(202) 260-2090
FAA	Federal Aviation Administration www.faa.gov	(202) 366-4000
FCC	Federal Communications Commission www.fcc.gov	(202) 418-0190
FDA	Food and Drug Administration www.fda.gov	(888) 463-6332
GSA	General Services Administration www.gsa.gov	(202) 708-5082
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
LBL	Lawrence Berkeley Laboratory (See LBNL)	
LBNL	Lawrence Berkeley National Laboratory	(510) 486-5605

	www.lbl.gov	
NCHRP	National Cooperative Highway Research Program (See TRB)	
NIST	National Institute of Standards and Technology www.nist.gov	(301) 975-6478
OSHA	Occupational Safety & Health Administration www.osha.gov	(202) 693-1999
RUS	Rural Utilities Service (See USDA)	(202) 720-9540
TRB	Transportation Research Board www.nas.edu/trb	(202) 334-2934
USDA	Department of Agriculture www.usda.gov	(202) 720-2791
USPS	Postal Service www.usps.com	(202) 268-2000

E. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CAPUC	(See CPUC)	
CBHF	State of California, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation www.dca.ca.gov/bhfti	(800) 952-5210 (916) 445-1254
CPUC	California Public Utilities Commission www.cpuc.ca.gov	(415) 703-2782
TFS	Texas Forest Service Forest Products Laboratory //txforestservice.tamu.edu	(936) 639-8180

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 60 00 – PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. Related Sections include the following:

1. Division 1 Section "References" for applicable industry standards for products specified.
2. Division 1 Section "Closeout Procedures" for submitting warranties for contract closeout.
3. Divisions 2 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.2 DEFINITIONS

A. Products: Items purchased for incorporating into the Work. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

C. Product Specification: Where a specific manufacturer's product is, including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.3 SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use form provided at end of Section.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

   a. Statement indicating why specified material or product cannot be provided.
   b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Government and separate contractors that will be necessary to accommodate proposed substitution.
   c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
   d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
   e. Samples, where applicable or requested.
   f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
   g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
   h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
   i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
   j. Cost information, including a proposal of change, if any, in the Contract Sum.
   k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
   l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods

compatible with products and construction methods of other contractors.

2. If a dispute arises between contractors over concurrently selectable but incompatible products, the Contracting Officer will determine which products shall be used.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products to allow for inspection and measurement of quantity or counting of units.
6. Store materials in a manner that will not endanger Project structure.
7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
9. Protect stored products from damage.
10. Product shall be stored and handled in a safe manner and housekeeping conducted daily to the satisfaction of the Contracting Officer.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
4. Or Equal: Where products are specified by name and accompanied by the term

"or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

2.2 PRODUCT SUBSTITUTIONS

A. Timing: The Contracting Officer will consider requests for substitution if received within 90 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of the Contracting Officer.

B. Conditions: The Contracting Officer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, the Contracting Officer will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers the Government a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities the Government must assume.
2. Requested substitution does not require extensive revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution is compatible with other portions of the Work.
7. Requested substitution has been coordinated with other portions of the Work.
8. Requested substitution provides specified warranty.
9. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 – EXECUTION: (Not Used)

END OF SECTION 01 60 00

Advancement of Construction Technology

SUBSTITUTION REQUEST
(After the Bidding Phase)

Project: _____ Substitution Request Number: _____

_____ From: _____

To: _____ Date: _____

_____ Project Number: _____

Re: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 2-5 years old ☐ 5-10 yrs old ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

_____

_____

☐ Point-by-point comparative data attached

Reason for not providing specified item: _____

_____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

_____

Savings to Government for accepting substitution: _____ ($ _____).

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

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SUBSTITUTION REQUEST
(Continued)

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

_____

Telephone: _____

Attachments: _____

_____

_____

_____

GOVERNMENT'S REVIEW AND ACTION

☐ Substitution approved - Make submittals in accordance with Specification Section 01330.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01330.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: Date:

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ A/E ☐ COTR

_____

_____

_____

_____

_____

_____

_____

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SECTION 01 70 00 – PROJECT MEETINGS

PART 1 - GENERAL

1.1 PRECONSTRUCTION CONFERENCE

A. The Contractor shall attend a preconstruction conference scheduled by the Contracting Officer. Work shall not commence prior to the conference. Subcontractor representatives shall attend. Discussion shall address project orientation, personnel contact, safety issues, permits, deficiencies, and the location of the Contractor's office.

1.2 PROJECT MEETINGS

A. The Contractor shall attend weekly project meetings scheduled by the Government to discuss safety, the project submittal schedule, and the project progress Schedule, and construction issues. The Contractor shall provide a representative from his organization with expertise and knowledge in matters related to the project Schedule. The representative shall have the responsibility of updating and coordinating the Schedule with actual job conditions. During this meeting, the Contractor shall describe, on an activity-by-activity basis, all proposed revisions and adjustments to the project Schedule required to reflect the current status of the project. The Contracting Officer shall approve activity progress, proposed revisions and adjustments as appropriate. Only Contracting Officer approved revisions and adjustments shall be incorporated into the schedule. The representative shall also present current information on the status of purchase orders, shop drawings, off-site fabrication, material deliveries, Subcontractor activities, anticipated needs for any Government-Furnished Equipment (GFE), and any problem which may impact the contract performance period. Subcontractor representatives shall attend as appropriate and as requested.

PART 2 – PRODUCTS: (Not Used)

PART 3 – EXECUTION: (Not Used)

END OF SECTION 01 70 00

SECTION 01 73 10 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:

1. Division 7 Section "Through-Penetration Firestop Systems" for patching fire-rated construction.
2. All Division Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work. Refer to mechanical and electrical Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations

1.2 DEFINITIONS

A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.3 SUBMITTALS

A. Cutting and Patching Proposal: Unless otherwise determined by the COR, the contractor shall submit, at least 10 days before the time of cutting and patching, a proposal describing procedures that will be performed, and request approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Products: List products to be used and firms or entities that will perform the Work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
6. Structural Elements: Where cutting and patching involve modification of any structural element, submit details showing the proposed modification and integration with original structure.

1.4 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch the following operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Fire-protection systems.
4. Control systems.
5. Communication systems.
6. Conveying systems.
7. Electrical wiring systems.
8. Operating systems of special construction.

C. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

1. Water, moisture, or vapor barriers.
2. Membranes and flashings.
3. Exterior curtain-wall construction.
4. Equipment supports.
5. Piping, ductwork, vessels, and equipment.
6. Noise- and vibration-control elements and systems.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1. Retain recognized, experienced, and specialized firm to cut and patch exposed Work listed below.

a. Processed concrete finishes.
b. Stonework and stone masonry.
c. Ornamental metal.
d. Preformed metal panels.
e. Roofing.
f. Firestopping.
g. Window wall system.
h. Fluid-applied flooring.
i. Aggregate wall coating.
j. Wall covering.
k. HVAC enclosures, cabinets, or covers.

E. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections of these Specifications.

B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, coordinate with COR to minimize interruption of services to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
5. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

END OF SECTION 01 73 10

SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 01 06 50 “Environmental Compliance” for MSFC specific waste management procedures
2. Section 31 10 00 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements. [delete if N/A]

1.3 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

G. Total Recovered Material: Waste materials and byproducts that have been recovered or diverted from solid waste, but does not include materials and byproducts generated

from, and commonly reused within, an original manufacturing process.

1.4 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

B. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Waste:

    a. Masonry and CMU.
    b. Wood.
    c. Metals.
    d. Asphalt.
    e. Concrete.
    f. Mechanical equipment.
    g. Refrigerants.
    h. Electrical equipment.

2. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

    a. Paper.
    b. Cardboard.
    c. Boxes.
    d. Recyclable plastics.
    e. Wood crates/pallets.

1.5 SUBMITTALS

A. Waste Reduction Report: Concurrent with each Application for Payment, submit report. Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work. Use Form CWM-1.

B. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations.

C. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations.

D. Landfill and Incinerator Disposal Records or Recycling and Processing Facility Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities or of recyclable waste by recycling and processing facilities licensed to accept them. Include

manifests, weight tickets, receipts, and invoices.

1.6 QUALITY ASSURANCE

A. Waste Management Conference: Conduct conference at Project site. Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

PART 2 - PRODUCTS

2.1 WASTE REDUCTION REPORT:

A. Use Form CWM-1. Include the following information:

1. Material category.
2. Total quantity of waste in tons.
3. Total quantity of waste recovered (salvaged plus recycled) in tons.
4. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Division 01 Sections.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Division 01 Sections for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGED MATERIALS

A. Salvaged Items for Reuse Salvage items for reuse and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Turn over to the COR or install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation: Not permitted to be stored on Project site.

C. Lighting Fixtures: Protect from breakage.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

NOTE: The policies, procedures and restrictions of the landfill and recycling organizations above are not governed by NASA and are subject to change. All contractors should contact these agencies directly to familiarize themselves with the policies, procedures and restrictions prior to bidding and prepare their bids accordingly. Listed below is provided for information only. Available recycling receivers and processors include, but are not limited to the following:

Solid Waste Disposal Authority, Huntsville, Alabama; 1-256-830-BINS

PBS Services, Inc, Huntsville, Alabama; 256-656-3710

Waste Management Services, Huntsville, Alabama; 1-256- 256-759-3915

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

   a. Inspect containers and bins for contamination no less than monthly and remove contaminated materials if found.

2. Do not store within drip line of remaining trees.
3. Store components off the ground and protect from the weather.
4. Remove recyclable waste from Government's property.

3.4 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: If greater than 15 tons are to be demolished, asphalt materials shall be recycled.

1. The size of the asphalt shall not be larger than 3'x3'x3'

B. Concrete:

1. Non-structural concrete shall be recycled.
2. If greater than 15 tons of structural concrete are to be demolished, structural concrete materials shall be recycled.
3. The size of the concrete shall not be larger than 3'x3'x3'.
4. Concrete shall be clean of dirt and debris as practicable.

C. Metals: Separate metals by type.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Paper: As much as possible, recycle paper.
2. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
3. Recyclable Plastics: As much as possible, recycle plastics packaging.
4. Wood Crates/Pallets: As much as possible, require deliveries using crates/pallets to remove crates/pallets from Project site.

3.6 DISPOSAL OF WASTE

A. Burning: Do not burn waste materials.

B. Disposal: Transport waste materials and dispose at the Redstone Arsenal Landfill, if permissible, or legally dispose off the Government's property. Review Division 01 Section "Environmental Compliance" for further disposal information.

3.7 REDSTONE ARSENAL LANDFILL (RSAL) (Phone # 256-876-4199)

A. The following restrictions concerning use of the Government's Redstone Arsenal Landfill (RSAL) are provided for general use as an example of some of the policies and restrictions that historically have been associated with the RSAL. They are not to be considered complete or necessarily correct. The policies, procedures, and restrictions of the landfill and recycling organizations above are not governed by NASA and are subject to change. All contractors should contact these agencies directly to familiarize themselves with the policies, procedures, and restrictions prior to bidding and prepare their bids accordingly.

1. No garbage shall be mixed in with the construction rubble for disposal at the Redstone Arsenal Landfill (RSAL).
2. No liquids of any kind shall be disposed of at the RSA
3. No ammunition or explosive type material (including training devices) shall be disposed of at the RSAL.
4. No batteries shall be disposed of at the RSAL.
5. No hazardous wastes shall be disposed of at the RSAL, except asbestos as noted herein.
6. Large pieces of heavy metal, copper, metal shavings, etc. shall not be disposed of at the RSAL.
7. Asbestos shall be segregated and disposed of in a designated area of the RSAL.
8. Cans of 1 gallon or larger that contain paint, solvent, or any other liquid shall not be disposed of in the RSAL.
9. Empty drums in good condition from 5-gallon containers and up shall not be disposed of in the RSAL.
10. Empty drums in poor condition shall be flattened prior to delivery for disposal to the RSAL.
11. There will be no loitering or scrounging at the RSAL.

B. For all demolition and construction waste to be disposed of at the RSAL, the Contractor shall submit documentation ensuring compliance with ADEM Permit No. 45-3 issued for the RSAL. The MSFC Environmental Engineering and Occupational Health Office (AS10) will provide to the Contractor the Certification Number to be used for the project. The Contractor shall complete all applicable portions of the form's "Material Certification" page except as described below. Upon completion, the Facility Management Office Construction Support Contractor shall submit the "Material Certification" to AS10. MSFC AS10 will complete the "Waste Certification" and "Material Certification" sections of the Form 2435-R and forward it to the RSAL. The Contractor shall complete a Form 2435-R, "Delivery Ticket" for each load using the specific project's Certification Number.

C. The Government will refuse any material or not allow dumping of any material at the site if it does not meet the RSAL requirements. If this occurs, the Contractor is responsible to dispose of the waste material offsite at approved landfills at his own expense.

3.8 ATTACHMENTS

A. Form CWM-1 for construction waste.

END OF SECTION

FORM CWM-1: WASTE REDUCTION REPORT

PROJECT TITLE: **DATE:**

CONTRACT #: **PROGRESS:** ☐

CONTRACTOR NAME: **END OF PROJECT:** ☐

CONTRACTOR POC: **PHONE #:**

MATERIAL CATEGORY	GENERATION POINT	HANDLING AND TRANSPORTATION PROCEDURES (LEED PROJECT ONLY)	REMARKS AND ASSUMPTIONS (LEED PROJECT ONLY)	TOTAL QUANTITY OF WASTE TONS (A)	QUANTITY OF WASTE SALVAGED		QUANTITY OF WASTE RECYCLED		TOTAL QUANTITY OF WASTE RECOVERED TONS (D = B + C)	TOTAL QUANTITY OF WASTE RECOVERED % (D / A x 100)
					ESTIMATED TONS (LEED PROJECT ONLY)	ACTUAL TONS (B)	ESTIMATED TONS (LEED PROJECT ONLY)	ACTUAL TONS (C)		
Packaging: Paper										
Packaging: Cardboard										
Packaging: Boxes										
Packaging: Recyclable plastics										
Packaging: Wood crates/Pallets										
Masonry and CMU										
Wood										
Metals										
Asphalt										
Concrete										
Mechanical Equipment										
Refrigerants										
Electical Equipment										
Other:										

SECTION 01 77 00 – CLOSEOUT PROCEDURES

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes, but is not limited to, administrative and procedural requirements for contract closeout.

B. Related Sections include the following:

1. Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
2. Division 1 Section "Demonstration and Training" for requirements for instruction of the Government's personnel.
3. Divisions 2 through 16 Sections for specific closeout and special cleaning requirements for products of those Sections.

1.2 FINAL INSPECTION

A. Before requesting final inspection, complete the following:

1. All salient parts of the work are substantially complete.
2. All systems and subsystems are substantially complete.
3. Startup testing of systems are complete.
4. Submission and approval of adjust/balance records.
5. Submission and approval of Operation and Maintenance Manuals.
6. Instruct Government's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, the Government will either schedule a day for the inspection or reject the Contractor's request for due cause. Requests for "partial" final inspections will only be considered when multiple and functionally separate buildings are involved or when the project is phased or when systems or occupancies are required by the Government. The Government reserves the right to reject all "partial" requests.

1.3 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. After final inspection, the Government shall issue a punchlist to be completed by the Contractor.

1.4 PROJECT CLOSEOUT SUBMITTALS

A. As-built Drawings: Submit the redlined as-built drawing set maintained by the Contractor and verified by the Government.

B. Record Submittals: Submit one hard copy and CD ROM that includes all project submittals. Create CD ROM of submittals using *.PDF format from Adobe Acrobat Author. CD ROM to contain Acrobat Reader. Submittals to be indexed by the use of “AcroBld” program, available from NASA or from Internet http://mroed-d_3.mro.usae.army.mil/EBS.HTM.

C. Operation and Maintenance Manuals: Submit operation and maintenance data in accordance with Division 1 – Operations and Maintenance Data.

D. Warranties: Organize warranty documents into an orderly sequence.

1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8- 1/2-by-11- inch (115-by- 280- mm) paper.
2. Provide heavy paper dividers with plastic -covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
4. Provide additional copies of each warranty and include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 AS-BUILT DRAWINGS

A. As-built Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings at the project site.

1. Preparation: Mark As-built Prints completely and accurately to show the actual installation where installation varies from that shown originally.

   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Accurately record information in an understandable drawing technique.
   c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
   d. For DCR’s, RFI’s, CDR’s, and Change Items, cloud the area on the drawing affected by the change, note the changing document number, and attach the approved changing document to the affected drawing.

2. Content: Types of items requiring marking include, but are not limited to, the following:

   a. Dimensional changes to Drawings.
   b. Revisions to details shown on Drawings.
   c. Depths of foundations below first floor.
   d. Locations and depths of underground utilities.

e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order.
k. Changes made following the Contracting Officer's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.
n. Record information on the Work that is shown only schematically.
o. Note and dimension all underground utilities and structures (including existing) on the drawings.

3. Mark as-built set with red-colored pen.
4. Mark important additional information that was either shown schematically or omitted from original Drawings.

2.2 RECORD SUBMITTALS

A. Preparation: Mark Record Submittals to indicate the actual product installation where installation varies substantially from that indicated in the data submittal.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period. Post changes and modifications to Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Provide access to Project Record Documents at the project site during normal working hours.

3.2 PROJECT CLOSEOUT

A. General: The final pay application shall not be accepted by the Government until all contract requirements are met and the following is performed.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations:

a. Clean Project site, yard, and grounds, in areas disturbed by construction

activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
f. Sweep concrete floors broom clean in unoccupied spaces.
g. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
h. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
i. Remove labels that are not permanent.
j. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
k. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
l. Wipe surfaces of mechanical and electrical equipment, [elevator equipment] and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
m. Replace parts subject to unusual operating conditions.
n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
p. Clean ducts, blowers, and coils if units were operated without filters during construction.
q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
r. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
s. Leave Project clean and ready for occupancy.

C. Complete all punchlist items.

D. Demobilize and remove all temporary utilities.

E. Complete all submittal requirements.

F. All permits shall be closed out, notifications made, and hazardous wastes removed.

G. All DCR's signed and closed out.

H. Turn in excess and salvage materials and spare parts as required.

I. Security: Turn in badges, decals, passes, keys, and all other security items.

J. Final Reports: Finalize hazardous chemical inventory, Contractor accident and safety statistics.

K. Release all liens.

3.3 PUNCHLIST

A. The Contractor shall complete all punchlist items as quickly as possible but within 30 days after final inspection.

END OF SECTION 01 77 00

SECTION 01 78 20 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Operation and Emergency manuals for systems, subsystems, and equipment.
3. Maintenance manuals for the care and maintenance of products, materials, and systems and equipment.

B. Related Sections include the following:

1. Division1 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Division1 Section "Closeout Procedures" for submitting operation and maintenance manuals.
3. Refer to applicable sections for specific operation and maintenance manual requirements for products in those Sections.

1.2 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 SUBMITTALS

A. O & M Manual(s) Submittal: Submit 2 hard copies of each manual in final form at least 30 days before final inspection. In addition to hard copies of each manual, provide CD ROM of operation and maintenance data using PDF format from Adobe Acrobat.

1.4 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include a list of equipment for each system.

C. List of Equipment: List equipment organized alphabetically that is not already listed as a part of a system or subsystem.

D. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with the same designation used in the Contract Documents. If no designation exists, consult with the COR.

2.2 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Date of submittal.
4. Name, address, and telephone number of Contractor.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (115-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

    a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets by stating Volume ___ of ___, where the first blank is the subject volume and the second blank is the total number of volumes.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch (115-by-280-mm), 20-lb/sq. ft. (75-g/sq. m) white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 OPERATION AND EMERGENCY MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.

7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.
11. Type of Emergency
12. Emergency instructions
13. Emergency procedures

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification by MAXIMO number with corresponding serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special/Emergency operating instructions and procedures.

D. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

E. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

F. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

G. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

H. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties: Provide separate booklet of warranties and lists of circumstances and conditions that would affect validity of warranties.

1. Include procedures to follow and required notifications for warranty claims.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in the manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard printed maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties: Provide separate booklet of warranties and lists of circumstances and conditions that would affect validity of warranties.

1. Include procedures to follow and required notifications for warranty claims.

2.6 COMMISSIONING O & M MANUAL

A. Submit in accordance with Section 01 91 13.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

C. Emergency, Operation and Maintenance Manuals: Assemble a complete set of emergency, operation and maintenance data and procedures indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Manuals may be used by emergency personnel and by Owner’s operating personnel for types of emergencies indicated.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

D. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work by MAXIMO number if applicable. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents by MAXIMO number if applicable. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

E. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in As-Built Drawings to ensure correct illustration of completed installation.

F. Comply with Division 1 Section "Closeout Procedures" for the schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 20

SECTION 01 82 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for training Government's personnel in the operation and maintenance of systems, subsystems, and equipment.

1.2 SUBMITTALS

A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, and instructors' names for each training module. Include learning objective and outline for each training module.

1. At completion of training, submit one complete training manual(s) for the Government's use in CD .pdf format.

B. Qualification Data: For firms and instructors identified in "Quality Assurance" demonstrate their capabilities and experience to conduct training for the system and equipment specified. Include lists of previous training on completed projects with project names and addresses, and other information specified.

C. Demonstration and Training DVD: Submit two copies at end of each training module.

1.3 QUALITY ASSURANCE

A. Trainer Qualifications: A firm or individual experienced in training maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

1.4 COORDINATION

A. Coordinate instruction schedule with the Government's operations. Adjust schedule as required to minimize disrupting the Government's operations.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation,

and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the Government.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:

1. Motorized doors, including overhead coiling doors, overhead coiling grilles, and automatic entrance doors.
2. Fire-protection systems, including fire alarm, fire pumps, and fire-extinguishing systems.
3. Intrusion detection systems.
4. Conveying systems, including elevators, wheelchair lifts, escalators, and cranes.
5. Laboratory equipment, including laboratory air, and vacuum equipment and piping.
6. Heat generation, including boilers; feed water equipment, pumps, steam distribution piping, and water distribution piping.
7. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
8. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
9. HVAC instrumentation and controls.
10. Electrical service and distribution, including transformers, switchboards, panel boards, uninterruptible power supplies, and motor controls.
11. Packaged engine generators, including transfer switches.
12. Lighting equipment and controls.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following, if applicable:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated design responsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations manuals.
    c. Maintenance manuals.
    d. Identification systems.
    e. Warranties.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.
    d. Regulation and control procedures.
    e. Control sequences.
    f. Safety procedures.
    g. Instructions on stopping.
    h. Normal shutdown instructions.
    i. Operating procedures for emergencies.
    j. Operating procedures for system, subsystem, or equipment failure.
    k. Seasonal and weekend operating instructions.
    l. Required sequences for electric or electronic systems.
    m. Special operating instructions and procedures.

5. Adjustments: Include the following:

    a. Alignments.
    b. Checking adjustments.
    c. Noise and vibration adjustments.
    d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

    a. Diagnostic instructions.
    b. Test and inspection procedures.

7. Maintenance: Include the following:

    a. Inspection procedures.
    b. Types of cleaning agents to be used and methods of cleaning.
    c. List of cleaning agents and methods of cleaning detrimental to product.

d. Procedures for routine cleaning
e. Procedures for preventive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs: Include the following:

a. Diagnosis instructions.
b. Repair instructions.
c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
d. Instructions for identifying parts and components.
e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

3.2 INSTRUCTION

A. Trainer: Engage a qualified trainer to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and the Government for number of participants, instruction times, and location.

B. Provide instructors to instruct the Government's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

C. Schedule training with the Government at least fourteen calendar days' advance notice.

D. Demonstration and Training Session: Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. For each training module, submit list of participants and length of instruction time.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

E. Cleanup: Collect used and leftover educational materials and give to the Government. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 01 82 00

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

A. This Section addresses cast-in-place concrete, including reinforcement, concrete materials, mix design, placement procedures, and finishes to be used in the following applications:

1. Curb and Gutter
2. Utility Pads
3. Walkways

B. See Division 2 Section "Earthwork" for drainage fill under slabs-on-grade.

1.3 SUBMITTALS

A. The following shall be submitted in accordance with Section 01330, “Submittal Procedures,” in sufficient detail to show full compliance with the Contract Documents.

B. Product Data: For each manufactured material and product indicated.

C. Design Mixes: For each concrete mix indicated.

D. Shop Drawings: Include details of steel reinforcement placement including material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports.

E. Material certificates and test reports.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment. Firm shall be a current member of NRMCA.

B. Comply with ACI 301, "Specification for Structural Concrete," including the following, unless modified by the requirements of the Contract Documents.

1. General requirements, including submittals, quality assurance, acceptance of structure, and protection of in-place concrete.

2. Formwork and form accessories.
3. Steel reinforcement and supports.
4. Concrete mixtures.
5. Handling, placing, and constructing concrete.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Formwork: Furnish formwork and form accessories according to ACI 301.

B. Steel Reinforcement:

1. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
2. Plain-Steel Wire: ASTM A 82, as drawn.
3. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

C. Concrete Materials:

1. Portland cement: ASTM C 150, Type I.
2. Normal-Weight Aggregate: ASTM C 33, uniformly graded, not exceeding 1-1/2-inch nominal size.
3. Lightweight Aggregate: ASTM C 330.
4. Water: Complying with ASTM C 94.
5. Synthetic Fiber: Fibrillated or monofilament polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

D. Admixtures:

1. Air-Entraining Admixture: ASTM C 260.
2. Water-Reducing Admixture: ASTM C 494, Type A.
3. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
4. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
5. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

E. Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10-mils thick.

1. Fine-Graded Granular Material: Clean mixture of crushed shone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100% passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

F. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

G. Curing Materials:

1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for

application to fresh concrete.
2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf.
3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
4. Water: Potable.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
6. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.2 CONCRETE MIXES

A. Comply with ACI 301 requirements for concrete mixtures.

B. Prepare design mixes, proportioned according to ACI 301, for normal-weight concrete determined by either laboratory trial mix or field test data bases, as follows:

1. Compressive Strength (28 Days): 4000-psi.
2. Slump: 2 to 5 inches.

a. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches after adding admixture to plant- or site-verified, 2- to 3-inch slump.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 4 to 7 percent.

1. Air content of trowel-finished interior concrete floors shall not exceed 3.0 percent.
2. Limit slump to 5 inches for troweled slabs.

D. Macro synthetic fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 1.5 lb. / cu. yd.

2.3 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with ASTM C 94.

1. When air temperature is between 85° F and 90° F, reduce mixing and delivery time from 90 minutes to 75 minutes; when air temperature is above 90° F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.

C. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 – EXECUTION

3.1 INSTALLATION, GENERAL

A. Formwork: Design, construct, erect, shore, brace, and maintain formwork according to ACI 301.

B. Vapor Retarder: Install, protect, and repair vapor-retarder sheets according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.

1. Lap joints 6 inches and seal with manufacturer's-recommended tape.
2. Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of + 0 inch or - 3/4 inch.

C. Steel Reinforcement: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

D. Joints: Construct joints true to line with faces perpendicular to surface plane of concrete.

1. Construction Joints: Locate and install so as not to impair strength or appearance of concrete, at locations indicated or as approved by Architect.
2. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

   a. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

3. Contraction Joints in Slabs-on- Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

   a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
   b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints

into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

E. Tolerances: Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3.2 CONCRETE PLACEMENT

A. Comply with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

B. Do not add water to concrete during delivery or after placement has started. Never exceed the maximum water-cement ratio.

C. Consolidate concrete with mechanical vibrating equipment.

3.3 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Completely remove fins and other projections.

1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
2. Do not apply rubbed finish to smooth-formed finish.
3. Apply smooth-rubbed finish, defined in ACI 301, to smooth-formed finished concrete.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.4 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on the surface.

1. Do not further disturb surfaces before starting finishing operations.

C. Scratch Finish: Apply scratch finish to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finish, unless otherwise indicated.

D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built- up or membrane roofing, or sand-bed terrazzo.

E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.

F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

G. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.5 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection, and follow recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions occur before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

D. Cure formed and unformed concrete for at least seven days as follows:

1. Moisture Curing: Keep surfaces continuously moist with water or use absorptive cover, water saturated and kept continuously wet.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to

heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Tests will be performed according to ACI 301.

1. Testing Frequency: One composite sample for each day's pour of each concrete mix exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: At least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.

END OF SECTION 03 30 00

SECTION 23 09 23 - DIRECT DIGITAL CONTROL/UTILITY CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section applies to all Utility Control System instrumentation. Product quality, installation, and operation shall meet the requirements specified herein unless indicated otherwise on the design drawing(s).

B. The existing UCS architecture consists of multiple LAN segments supporting dual servers, operator workstations, printers and Ethernet to MS/TP data routers supporting multiple MS/TP LANs. The MS/TP networks include point-to-point modems and data converters used to extend each MS/TP LAN segment. Operator workstations are Windows 7 based systems running Dorsett's Infoscan, and other custom applications. Servers are Windows Server 2008 based systems running Dorsett Technologies Inc.'s Infoscan and Oracle Database Manager. The UCS monitors and/or controls more than 3.5 million square feet of conditioned space in excess of 100 buildings, comprising more than 20,000 connected field devices and supporting an excess of 40,000 points. Due to MSFC's multi-million dollar investment in the large installed UCS product base and to ensure 100% compatibility with the existing hardware and software, all construction, renovation or modification of facilities shall be an extension of the existing UCS architecture. For all modifications and/or additions that include UCS or affect UCS, the design of the UCS control system network and UCS equipment is done by a specialized "in-house" UCS design group at MSFC.

1.2 PRE-CONSTRUCTION MEETING

A. A control system pre-construction meeting shall be held prior to undertaking any control system construction installations at MSFC. The purpose of the meeting is to review this specification and discuss the project prior to starting work. Proper construction techniques and expected results will be discussed. In general, this meeting will address questions, or concerns, by any party, so that a clear understanding of the job scope and contractor responsibility is understood.

B. The contractor's construction supervisor or field manager must attend this meeting. The following individuals shall attend this meeting:

1. Project Manager/COR
2. Construction Inspector
3. Utility Control System Representative
4. Utility Control System Designer
5. Contractor Construction Supervisor
6. Commissioning Authority

1.3 QUALITY ASSURANCE

A. The instrumentation installation shall be under the direct supervision of individuals with a minimum of 5-years experience in the installation and service of similar instrumentation.

1.4 RELATED SECTIONS

A. Section 26 05 01 “Electrical Work, Interior,” applies to work specified in this section.

1.5 SYSTEM DESCRIPTION

A. Control system consists of sensors, indicators, final control elements, interface equipment, accessories, software, and other apparatus connected to distributed controllers operating in a multi-user, multitasking environment on Local Area Network(s), and programmed to control specified equipment.

1.6 SUBMITTALS

A. Product Data

1. Provide technical sheets on all system components shown on the design drawing(s).
2. Provide catalog cut-sheets, specifications, product data, warranty information and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents. A technical submittal must be submitted including specification compliance, technical sheets, and factory representative authorization. The technical submittal shall contain the following:
3. Specification Compliance: The compliance document shall address each paragraph of the specification by indicating COMPLY, EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the proposed system.

B. Shop Drawings (Control Schematic Drawings)

1 The Contractor may not start work until the complete control schematic drawings of the entire control system are approved by the Government.
2. The control schematic drawings shall have a key to all abbreviations.
3. The control schematic drawings will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4. Communication trunk diagrams shall designate and identify the specific building location of each application specific or multi-function controller card and the relative position of each card on respective trunks.
5. The Contractor shall provide detailed I/O point summaries indicating each instrumentation point with wire termination identifications for each point and grouped by individual I/O card.
6. Provide a full points list with at least the following included for each point.

a. Include:
   1) Control Points: Points that control equipment and can have setpoints changed (e.g., OSA, SAT)
   2) Intermediate Points: Points whose values are used to make calculations which then control equipment (e.g., space temperatures that are averaged to a virtual point to control reset).
   3) Calculated Points: "Virtual" points generated from calculations of other point values.
   4) Monitoring Points: Points that do not control or contribute to the control of equipment, but are used for operation, maintenance, or performance verification.

a. Provide the following information for each point:
   1) Controlled system
   2) Point abbreviation
   3) Point description (e.g., DB temp, airflow)
   4) Setpoint

C. Sequences of Operation- The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:

1. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
2. All interactions and interlocks with other systems.
3. Detailed delineation of control between any packaged controls and the building automation system, listing what points the UCS monitors only and what UCS points are control points and are adjustable.
4. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
5. Start-up sequences.
6. Warm-up mode sequences.
7. Normal operating mode sequences.
8. Unoccupied mode sequences.
9. Shutdown sequences.
10. Capacity control sequences and equipment staging.
11. Temperature and pressure control: setbacks, setups, resets, etc.
12. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
13. Effects of power or equipment failure with all standby component functions.
14. Sequences for all alarms and emergency shut downs.
15. Seasonal operational differences and recommendations.
16. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
17. Schedules, if known.

18. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

D. As-Built

1. Provide one hardcopy and compact disc (CD) in either Bentley Systems' Microstation or DXF format and shall include Contractor's original, untranslated drawing file. The as-builts shall include:

   a. Wiring diagrams
   b. System schematics
   c. Communication trunk layout

E. Test Plans, Trends, and Test Reports

1. Thirty days prior to the start of system verification, three (3) copies of written test plans describing control system verification and operational functionality procedures shall be submitted for Government approval. The Contractor is responsible for the development of the test plans. Test plans shall validate the intended purpose and operational effectiveness of the entire system; this includes all hardware devices and software sequences called for on the design drawings.
2. Control system verification procedures describing how the operation of each control loop will be verified shall be submitted by control loop, identifying each sensor, actuator, controller, transducer, and measuring device, as required. The procedures shall describe adjustments in terms of control component positions, input and output signals and ranges, air and water flow rates, temperature and humidity setpoints, calibration of valve and damper actuators and sensors, and all other pertinent control parameters. Submit bound copies of individual trend data, with table of contents, for each control loop identified on the contract drawings for verification of proper control loop operation, at least 30 days before Functional Performance Testing begins. Functional Performance Testing scheduled start date shall be obtained from the MSFC Commissioning Agent. Trend data shall identify that HVAC system that the control loop is installed in, control loop description (e.g., cooling coil control loop), control component designation (e.g., CCSAT-1, CHWV-1), and controlled component value or position for the duration of the control action. Trend data shall be provided for a minimum of two (2) control cycles to verify proper loop control operation.
3. Control system verification test reports describing test results of each control loop shall be submitted in bound form and shall indicate the final values and settings of each control component in each control loop. Where testing indicates a necessary deviation from the contract drawing sequences of operation and controls submittals, the Government shall be informed immediately. Any deviations shall be made only after Government approval and the test report shall note any changes in the control loop or component settings caused by the deviation. Seven (7) hardcopies and two (2) electronic copies on CD of the control system verification test report shall be submitted within 30 days after completion of testing.

F. Manufacturer's Instructions: Contractor shall submit three (3) hardcopies and three (3) electronic copies on CD of manufacturer's instructions describing installation of a product

or system, special notices and material safety data sheets concerning impediment, hazards, safety precautions, startup, shutdown, and emergency operation.

G. Operation and Maintenance Manuals: Operation and maintenance manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Contractor shall submit three (3) hardcopies and three (3) electronic copies on CD of O&M documentation. Operation and maintenance manuals shall be provided for all control system instrumentation products.

H. Qualification Data: The contractor shall submit a list of personnel qualifications, projects, dates, and control descriptions of installed systems as proof of experience installing similar instrumentation.

I. Course content and format of training materials.

1.7 TELECOMMUNICATIONS

A. Telecommunication lines are furnished by the Government. The Government will provide a telecommunication line between the construction site and the MSFC UCS network. The telecommunication line may be wired or wireless, as determined by the Government, and will be used through all testing and checkout phases, including commission. The Contractor shall submit a written request for the telecommunication line to the UCS Contractor 30 days prior to system startup.

PART 2 - PRODUCTS

The Controls Contractor shall furnish components required by design and described herein.

2.1 DIRECT DIGITAL CONTROL (DDC) EQUIPMENT

A. Utility Control System (UCS): This work includes all material, equipment, and appurtenant accessories necessary for, or incidental to, the installation of a complete Direct Digital Control (DDC) System as specified in the design package. The appropriately selected DDC configuration shall be capable of controlling processes in the building through configurable electronic controllers. This configurable hardware shall be electronically interfaced via an Interface Card (CPU), X-Talk or UNV-T-E card, manufactured by Dorsett Technologies Inc., http://www.dorsett-tech.com/, through telecommunication data lines to the central computer-based Utility Control System (UCS) located in Room 29 of Building 4250. Complete operational compatibility shall be maintained between the central UCS Infoscan system, both hardware and software, as manufactured by Dorsett Technologies Inc. and the direct digital controllers. The central host computer communicates via Government-furnished telecommunication lines and contractor installed modems to Dorsett's Interface Panel(s) located in the building(s) where the project is being performed. The Interface Panel communicates with application-specific controllers or multi-function controller cards, which implement direct control of equipment through industry standard electronic signals.

B. DDC hardware and software will communicate directly with the central host Infoscan application and that all existing UCS programs will function completely to control and

monitor related equipment. It also means that engineering units, values, or parameters utilized within the panels or controllers are compatible with units used within the Infoscan System. The field hardware and the central host computer shall communicate and be fully programmable from the host Infoscan application.

C. Operators shall have the ability to specify within the software and in standard engineering units the amount by which the point must change at the sensor before it is reported as changed to the UCS central servers in Building 4250. This feature provides a system function referred to as "report-by-exception. “Interface cards only report to the central computers value changes that exceed the selected delta value. This minimizes data traffic on telecommunication lines to and from the UCS central servers.

D. Each point that is used within the process shall be displayable and accessible through an Infoscan point review. When these points are represented as displayed values on computer graphic displays, operators shall be able to select these values with a point device and retrieve accurate data within 20 seconds.

E. Computer graphic displays shall be developed to represent each HVAC or environmental control component or system. These pictorial displays shall represent a chiller with all support pumps, valves, towers, air handlers, etc. All related analog and status points shall be dynamically represented on the display. If an analog or binary point changes value beyond the delta limit, this condition must be reported to an operator workstation within 20 seconds.

F. The Contractor shall perform all application programming and point configurations through existing operator workstations via Infoscan software. All programming and graphic display generation for a completely operational system shall be provided.

G. Field Interface Device: A Field Interface Device, also called FID, SID, MID, JID, etc., is a solid state electronic device with supporting software that provides an interface and permits communication between field controllers and the UCS servers. This device is the Dorsett's CPU card, X-Talk or UNV-T-E card into which the multi-function or application-specific cards are interfaced. It is connected via Government-furnished telecommunication lines to the UCS central servers in Building 4250. It has hardware and software compatibility with the existing Utility Control System. This card functions on a "report-by-exception" basis as described earlier in this section. If a new Interface Device is required, it shall be acquired from Dorsett Technologies Inc.

H. Multi-Function Controller Card: Is a solid-state electronic controller with universal input-output channels. All configuration parameters are fully programmable via the UCS central servers. Multifunction controller cards are manufactured by Dorsett Technologies Inc. include:

1. MS5-UNV
2. MS5 xTalk
3. SCADA Controller

I. Application-Specific Controller: An application-specific controller cards shall be connected and communicate to the UCS system through the CPU, UNV-T-E cards, or X-Talk. An example is an MS4-VAV controller.

J. Equipment Specific Controller (ESC): An equipment specific controller is any controller that is user programmable such as programmable logic controllers (PLC), PID controllers, etc. An ESC, when allowed by contract drawings and specifications, shall have all pertinent accessories included for the programming, downloading, and documentation of software. When available the contractor shall provide a Government approved programming device including software, cables, hardware locks, etc. to provide for the physical connection to the ESC and access to the non- volatile memory for programming of the ESC. Programming software shall be provided on factory media with all/any serial numbers, key codes, etc. such that the media can be registered with the manufacturer. For all ESC's, the contractor shall provide two (2) hardcopies of the factory programmed software logic. Owner's manuals and programming manuals shall also be included with all ESC installations. Where UCS control is desired, ESC's must be compatible with accepted UCS communication protocols. Examples of these protocols are:

1. BACnet – IP
2. BACnet – MSTP
3. Modbus RTU.

K. Control Panel (MUX):

1. A control panel is a completely configured field panel consisting of multi-function controller card(s), power supply(s), and terminal strips, fully contained within a UL listed, NEMA rated enclosure. Control panels manufactured by Dorsett Technologies Inc., are available in several sizes and configurations.
2. All control panels shall have a trough wire-way mounted above and below the enclosure for conduits to enter or exit. Chase nipples or conduits shall be used to connect the trough to the bottom of the control panel enclosure. Only penetrations in the bottom of the UCS control panel shall be made.
3. Control panels shall be mounted at a height of 72 inches from top of the control panel enclosure to finished floor or grade.

L. Unitary Thermostat:

1. All hydronic based systems and all packaged unitary direct expansion (DX) equipment shall be connected to the MSFC Utility Control System (UCS). DXAC units shall be capable of the serial connection to UCS via a communicating native BACnet MS/TP thermostat meeting the following criteria:
2. VI-PIR covers with integrated PIR (passive infrared) motion sensors with advanced active occupancy logic.
3. Single-stage and multi-stage control of heating/cooling equipment.
4. Available with optional built in economizer and humidity modes.
5. Lockable keypad.
6. LCD screen with backlight display.
7. Minimum of two digital inputs.
8. Accurate temperature control using PI proportional-integral algorithm.
9. EEPROM memory.
10. Auxiliary contact (Used for lighting equipment, exhaust fans, etc.)
11. OAT display when OAT sensor is connected.
12. Supports heat pump and economizer DXAC models.

13. Occupied/Unoccupied mode.
14. Can be powered from unitary equipment 19-30VAC.

M. Touch Screen Interface Display: Shall be resistive analog touch screen LCD type with an LED backlight. The unit shall require a 24VDC power supply. Touch screen interface panel shall include the following ports EIA-485, 10 Base T/100 Base/TX Ethernet port and USB communication port for software configuration. The touch screen unit shall communicate with MSFC building automation system (UCS) through serial interface via BACnet MS/TP. The touch screen unit shall be housed in a NEMA 4x enclosure and shall be wall mountable. Touch screen display shall be RedLion Model G315C or G306C or approved equal

2.2 FIELD DEVICES

A. General:

1. The use of interface signal converters is not allowed unless otherwise indicated on design drawings.
2. 24 volt AC power sources shall be 120 volt AC primary input, 4 amp minimum rated secondary, on/off switch, circuit breaker mounted in metal enclosure.
3. Uninterruptible Power Sources (UPS) shall have user accessible batteries, automatic voltage regulation and 1 KVA minimum capacity rating.
4. Acceptable industry standard analog voltage and current signals are as follows: 4 to 20mA, 0 to 20mA, 0 to 10VDC and 2 to 10VDC.

B. Temperature Sensor: Temperature sensors shall be 100 Ohm or 1000 Ohm 0.00385 coefficient platinum Resistance Temperature Detector (RTD). All temperature transmitters shall be provided as specified on the design drawings. Temperature sensors shall conform to DIN-IEC-751 class B (+/- 0.12%). As minimum requirements, the repeatability shall be +/- 0.1 degrees C and the stability shall be less then +/- 0.1 degree C drift per year. The transmitter shall be 4-20 mA loop powered having a calibration accuracy of +/- .1% of span and a linearity of 0.1% of span, unless otherwise specified.

1. Duct Temperature Sensor: Probe sensors for supply air and return air shall have rigid averaging elements and be installed horizontally extending two-thirds of the duct width as a minimum. Probe to four times duct width. Non-platinum 0.00385 coefficient RTD's having platinum equivalent accuracy may be used.
2. Room Temperature Sensor: Room sensors shall be provided with a high impact plastic cover. When connected to an application-specific controller the sensor shall include an access-port for communications.
3. Immersion Well Temperature Sensor: Immersion sensors with thermowells shall be installed in liquid and steam applications. Thermowells shall be stainless steel.

C. Pressure Sensor

1. Static Air Pressure Sensor: Pressure sensors shall be 4 to 20 milliamps, loop powered, 1/8-inch brass barb fittings and 1% full-scale accuracy. Static pressure sensors shall have a range approximately twice the setpoint called for in the sequence of operation. Duct static pressure sensors must be located downstream of fan 2/3 of the duct length.

2. Liquid and Gas Pressure Sensor: Pressure sensors shall be Setra Model 256 or approved equal. A snubber and pigtail siphon shall be installed in steam applications. Isolation valves shall be installed on each device port to facilitate removal/replacement.
3. Liquid and Gas Differential Pressure Sensor: Differential Pressure sensors used for gas and liquid applications shall be Setra Model 230 or approved equal. Isolation valves shall be installed on each device port to facilitate removal/replacement.
4. Low Differential Air Pressure Sensor: Pressure sensor shall be Setra Model 267 or approved equal.
5. Space Air Pressure Sensor: Space air pressure sensors shall be bi-directional, 4 to 20 milliamp loop powered unless otherwise specified.

D. Humidity Sensor Relative Humidity Sensor: Humidity sensors shall be plus or minus 3 percent minimum accuracy, unless otherwise specified. Sensor output signal shall be loop powered 4 to 20 milliamps. Humidity sensor shall be Vaisala Model HM92D series.

E. Pressure Switch

1. Air Differential Pressure Switch: Differential pressure switches for airflow confirmation shall be Dwyer Instruments Model 1910 series or approved equal.
2. Liquid Differential Pressure Switch: Differential pressure switches for proving water flow shall be Penn Model P74FA-5 or approved equal. Isolation valves shall be installed on each device port to facilitate removal/replacement.

F. Pneumatic Transducer: Pneumatic transducers shall be analog input, minimum supply pressure shall be 25 PSI, control range shall be 3 to 15 PSI, air connection shall be 1/8 inch brass barb or 1/8 inch FNPT and utilize electronic feedback pressure control. Branch line shall have a 0 to 30 PSI maximum range pressure gauge installed.

G. Actuators: Electronic actuators shall be 24 VAC powered, unless otherwise specified and operated by industry standard process signals. Examples are 4 to 20mA, 0 to 10V, Pulse-Width Modulation and 3- Point Floating.

H. Enclosures: Enclosures shall be UL listed, constructed of minimum 14 gauge sheet metal with spot welded joints, gray enamel finish and suitable for the application. Doors shall have a left-hand hinge and slotted-head screw operated latch.

I. Utilities Metering: All programmable utility meters as required on contract drawings shall have all pertinent accessories included for the programming, downloading, and documentation of software. When available the contractor shall provide a Government approved programming device including software, cables, hardware locks, etc. to provide for the physical connection to the meter and access to the nonvolatile memory for programming of the meter. For all programmable meters, the contractor shall provide two (2) hardcopies of the factory programmed software logic. Owner's manual and programming manual shall also be included with all installations.

J. Where discrete connections are specified, meter output(s) shall be directly connected to the Utility Control System DDC hardware. Meter electrical ratings shall be compatible with the Utility Control System DDC hardware. Pulse outputs shall indicate an accumulated quantity. Minimum pulse output duration shall be 0.25 seconds. Pulse

output type shall be open-collector/current sinking or form C relay contacts.

K. Voltage/Phase-loss monitor: Device shall be plug-in style selected per application; automatic reset type with DPDT form C relay outputs, adjustable trip setpoint.

L. Refrigerant/HCFC Monitor: Device shall have, at a minimum; scalable 4 to 20mA analog output indicating refrigerant levels in Parts-Per-Million (PPM) and programmable SPDT alarm relay.

M. Indoor Air Quality (IAQ): Device shall have an analog output corresponding to Carbon Dioxide (CO2) concentrations ranging from 0 to 2000 ppm.

N. Gas Detection: Gas detection devices, e.g. Oxygen Deficiency, Hydrogen, Fluorine and Carbon Monoxide shall have form C relay alarm output(s).

O. Current Switch: Device shall be capable of switching 150mA continuously. Split core design with adjustable trip point and capable of switching AC or DC circuits. Applicable for VFD applications down to 6Hz and powered by monitored line.

P. Water Level Detection: Device shall have 4 – 20mA output.

Q. Moisture Leak Detection: Device shall provide the following features:

1. By-zone form C relay interface capable of 32 alarm outputs
2. ALARM, FAULT, and HORN form C relay outputs
3. 36 hour battery backup
4. Capable of monitoring 32 independent zones
5. Provides subsequent alarming, no matter how many zones go into ALARM or FAULT
6. Identifies location, time & date of all ALARM and FAULT conditions displayed in chronological order via a LCD alphanumeric display
7. ALARM, FAULT and POWER front-panel mounted LED Indicators
8. Lineal leak detection tape

R. Variable Frequency Drive: VFD shall have an analog 0-20mA, 0- 10VDC, 2-10VDC, 4 – 20mA input for speed control, a contact closure input for start/stop control, and BACnet communications.

2.3 LABELING

A. Sensor and Control Devices: Each sensor and each control device shall be labeled at the sensor or device with the Infoscan database point name that identifies it. The point name shall be displayed in print achieved electronically or typographically on permanent adhesive labels. Minimum label size shall be 1 inch by 1/2 inch. Label color shall be white background. Printed text shall be black.

B. Enclosures: UCS control panels, as a minimum, shall be labeled. Labels shall be engraved plastic, beveled edges, black background, and white letters. Letter height shall be 1/2 inches minimum. Overall label dimensions shall be 1.25 inches minimum height, length as required. Labels shall be centered along width and located within upper 1/4

area of enclosure door. Minimum distance from top of enclosure shall be 3 inches. Labels shall be affixed with adhesive cement. Panels shall be labeled consistent with design drawing terminology.

C. Terminations: Each terminated wire shall be clearly labeled with white plastic sleeves displaying Field Device Infoscan point name (example AH1-SAF) at the Field Device and at each wire termination. Labeling shall display device or point names and shall be displayed in print achieved electronically or typographically. The Government shall approve labeling medium and method before work begins. Label shall be Brady model WMS-117- 319 or approved equal.

2.4 WIRING

A. Instrumentation/ Low Voltage and Data Communications Cable Wiring: All wiring shall be installed in dedicated conduit with the exception of plenum-rated wire which may be used in runs in concealed but accessible ceiling areas and computer room sub-floor only. A.C. power wiring greater than 24V shall not be installed in the same conduit, or pathway, with low voltage (24 volt or less) wiring. Conduit shall be 3/4 inches minimum diameter. Flexible conduit shall not exceed 3 feet in length and shall be ½ inch minimum in diameter. Wiring specifications are as follows:

B. Instrumentation/ Low Voltage Wiring:

1. 1-Pair, 22 AWG, stranded (7X30), twisted pair construction, 300 volt, polymer alloy-insulation, maximum O.D. of 0.15 inches, aluminum foil-polyester tape 100% shield, 24 AWG stranded drain wire, and plenum rated-jacket. Gray jacket with one black and one red wire. West Penn part #25291B or approved equal.
2. 2-Pair, 22 AWG, stranded (7X30) twisted pair construction 300, volt, polymer alloy-insulation, maximum O.D. of 0.21 inches, individual aluminum foil-polyester tape shielded pairs, 100% shield coverage, 24 AWG stranded (7X32) tinned copper drain wire, and plenum rated-jacket. Gray jacket with black/red and white/green wire pairs. West Penn part #25510B or approved equal.
3. Control Panel Instrumentation/ Low Voltage Wiring shall have shield/drain wires terminated only at a grounding bar in the wire trough located beneath the control panel. A 25 position (minimum) grounding bar shall be mounted and bonded to the wire trough bottom. A maximum of five shield/drain wires shall be terminated at each ground bar position. Shield/drain wires are not permitted in the control panel and shall remain within the wire trough enclosure.

C. Instrumentation/ Low Voltage Wires connecting field devices shall not be spliced or butted together. They shall be "home runs" from the field device to the panel.

D. Data Communications Cable Wiring:

1. 1-Pair, 24 AWG, stranded (7X32), characteristic impedance 120ohms, twisted pair construction, 300V, Foamed Teflon insulation, maximum cable diameter 0.202 inches, aluminum polyester foil 100% shield, 24 AWG stranded tinned copper drain wire, and plenum PVC rated-jacket. Gray jacket with one white/blue wire West Penn part #D254851, Belden part# 82841 or approved equal.

A. Data Communications Cable Conductors: The stripped portion of the stranded data communications cable shall be no more than 3 inches in length.

B. Data Communications Cable Shield/Drain Wire: Data Cable shall have shield/drain wire terminated only at the point of origin to the communication ground. The cable section where the stripped portion ends and the wire jacket begins shall be covered with heat shrinkable tubing. The drain wire length shall be kept to a minimum. The end point of the daisy chain configuration, at the last device, the shield/drain wire shall be cut and covered by heat shrinkable tubing. At connection points on the daisy chain configuration other than the origin or end shield/drain wires shall be connected via but-splice or soldered connection, so that the shield/drain wires are continuous throughout. Shield/drain wires shall not come into contact with any metal surface other than the points of termination.

C. Data Communications Cable Terminators: Each terminator shall be fabricated using 22/24 GA. Stranded lead wire soldered to the termination resistor leads. The lead wire shall be approximately 2 inches in length. The termination resistor and soldered connections shall be covered with heat shrinkable tubing. The termination resistors shall be 120 ohm resistors with 1% tolerance and ¼ watt minimum. A terminator is required, at the endpoints of the daisy chain configuration, on the data communications cable. One terminator shall be located at the point of origin which is the beginning of the data circuit. The other terminator shall be located at the last device in the data circuit /end of line.

D. 24 VOLT POWER WIRING: 2 Conductor, 16 AWG, stranded (19X29) wire for delivering low voltage power to 24 volt UCS connected devices. Plenum rated-jacket, 300 volt, polymer alloy insulation and maximum O.D. of 0.18 inches. Gray jacket with one black and one red-wire. West Penn part #25225B-or approved equal.

2.5 ELECTRICAL ISOLATION FIBER OPTICS

A. Electrical isolation to remote equipment requiring data communications with UCS shall require the following:

1. Industrial Serial to Multimode Fiber Converter basis of design B&B Electronics FOSTCDRI-INV.
2. 24 VDC Power Supply basis of design Mean Well MDR-40-24.
3. Outdoor Enclosure basis of design Hoffman P/N A20H1610ALLP/A20P16.
4. Multimode Fiber Optic Cable shall meet the following criteria:

    a. 62.5/125 µm
    b. Indoor/Outdoor Rated
    c. Suitable for underground conduit installations

5. Multimode Fiber Optic Cable Connectors shall meet the following criteria:

    a. ST Connector

2.6 NETWORK DISTRIBUTION

A. The Contractor shall furnish the modems specified below for installation as required on contract drawings.

B. HORIZONTAL FIBER OPTIC CABLE

1. Horizontal fiber optic cable shall be 8 µm singlemode tight buffered optical fiber, with fiber counts as indicated on drawings, with mechanical and transmission performance specifications that meet or exceed ANSI/TIA/EIA568B.3. Fiber cable shall be plenum rated and jacket shall be yellow in color.

C. CATEGORY 6 HORIZONTAL CABLE

1. Category 6 horizontal cables shall be solid copper, 24 AWG, 100 OHM, balanced twisted pair (UTP) with four individually twisted-pairs, plenum rated with orange jacket.

D. SINGLE PORT SURFACE MOUNT BOXES

1. Single port surface mount boxes shall be Category 6, white or ivory in color, data outlet 8 pin modular, un-keyed, orange, pinned to T568 A standards.

E. ENCLOSURE MOUNTED OPTICAL FIBER TERMINATION PANEL

1. All interconnect centers, panels and trays (units) shall provide cross-connect, interconnect, splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers.
2. All fiber optic cable enclosures shall conform to the following characteristics:

    a. Be available in Ivory or Black and be constructed of polymer plastic.
    b. Incorporate dual-level fiber managers to effectively store fiber cable slack in both the front and rear of the enclosure.
    c. Have cable access points for fiber jumpers entering and exiting the unit with rotating grommets to facilitate cable loading and to minimize micro bending stress.
    d. Have anchor points for securing fiber cable(s) entering unit.
    e. Have labeling that can be viewed with doors open or closed and meets or exceeds ANSI/TIA-606-A requirements and also be laser printable.
    f. Must be certified by Underwriters Laboratories to UL 1863 United States Standards and C22.2 Canadian Telecommunications Standards.

F. OPTICAL FIBER CONNECTORS

1. Ceramic tipped field installed LC type connectors, which meet or exceed the performance specifications in ANSI/TIA/EIA568-C.3.
2. All fiber optic connectors shall conform to the following characteristics:

    a. Meet the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA-604-10A.
    b. Be a pre-polished mechanical splice connector.
    c. Be available in simplex only versions.
    d. Utilize same XLR8 termination kit as the SC version.

e. Terminate 8 µm optical fiber.
f. Have a quick field termination using the manufacturer's tool incorporating a dual-process activation to reduce termination time.
g. Available for terminating 900 µm buffered fiber only.
h. Meet the following performance specifications:

Parameter	Peformance (dB)
Insertion Loss (typ)	0.2
Return Loss (typ)	-37

G. OPTICAL FIBER ADAPTERS

1. All Fiber optic panel adapters shall fit in the specified enclosure and meet the following characteristics:

   a. Be provided in options the offer interfaces to ST, SC, LC and FC terminated jumpers and pigtails.
   b. Provide for a maximum of 6-Duplex ST, 6-Duplex SC, 6-Quad LC or 4-Duplex FC on a single adapter plate.
   c. Offer a 12, 24 and 72 Strand MPO to MPO pass through adapter plate.
   d. LC, SC and ST universally accept both multimode and singlemode connectors.
   e. Include Red, Blue, Black and Clear colored icons for port identification.
   f. Be made of high impact flame-retardant thermoplastic.

H. NETWORK DISTRIBUTION ENCLOSURE

1. Hoffman NEMA 4 CONCEPT style wall mount enclosure, Model C-SD2424 (24" X 24" standard gray), or approved equal.
2. Single door enclosure with minimum 16 gauge steel construction and a continuous hinge on the left-hand side of the enclosure.
3. Each enclosure shall contain panel mounting studs with panels included.
4. Grounding stud on body with bonding provisions on door.
5. High-torque threadless studs and fasteners on door.
6. A minimum of one (1) keyed handle (Hoffman, P/N CWHK) shall be installed on each door. All doors shall be keyed the same.

I. CABLE SUPPORTS

1. Cable support devices used above ceilings throughout the primary corridors of the facility in which drop or suspended ceilings are present, shall be provided in a J-Hook configuration according to drawings. The Main corridor pathways are shown on the T-series drawings. The contractor shall utilize a typical 2" J-Hook for these applications.
2. Cable support devices above the drop ceiling off of the main corridors shall be provided by the cabling contractor. The contractor shall utilize a typical 2" J-Hook for these applications.

3. Cable supports shall be used when conduit and cable tray are not present to support the cabling.
4. Supports shall be placed at 48”-60” intervals.

J. CATEGORY 6 PATCH CORDS

1. Patch cord(s) shall be Category 6 stranded UTP cable with molded snagless boot and strain relief, orange jacketed. Patch cords shall be of sufficient length to allow for a minimum of 12” of slack at each end.

K. FIBER OPTIC PATCH CORDS

1. Fiber optic patch cord(s) shall be 8 µm duplex singlemode, LC type connectors with strain relief and dust caps, 1 meter in length and yellow jacketed. Attenuation testing shall be in accordance with EIA/TIA-455-171A.

L. GIGABIT ETHERNET NETWORK SWITCHES

1. Basis of design is a MOXA 9-port full gigabit managed Ethernet switch, or approved equal.

    a. All ports within the switch shall be rated for 10/100/1000T(X). Full duplex transmission shall be accomplished through any port on the switch.
    b. Each switch shall produce a minimum of 5 duplex fiber optic ports either dedicated to a duplex LC connection or via standard small form factor pluggable (SFP) ports. All SFP ports shall be equipped with MOXA model SFP-1GSXLC.
    c. Each of the SFP ports shall have the capability to plug in a compatible RJ-45 copper SFP or have a dedicated copper port associated with the SFP port. The solution shall provide an “either/or” port availability. The user can utilize the SFP port or copper port associated but not both.
    d. Each switch shall have a minimum of 4 dedicated copper ports providing 10/100/1000T(X) transmission capability.
    e. Each switch shall be DIN-rail mounted for ease of installation in the referenced enclosure.
    f. Each switch shall have dual redundant power input slots, each within the capability of accepting 12/24/48 VDC from the power supply.
    g. Each switch shall be industrial grade providing operational capability in temperatures of 0-60 degrees Celsius.

M. xDSL MODEM

1. Telecommunication lines are furnished by the Government. If installation of a communication line to a new xDSL modem is required, the Contractor shall submit a written request to the UCS Contractor 30 days prior to system startup.
2. Basis of design is a FlexDSL MiniFlex high bit rate modem model # MF-PAM-RAIL2N-2ETH-24V, V1, or approved equal.

    a. Each xDSL modem shall be DIN-rail mounted for ease of installation within the referenced enclosure.

b. Each modem shall be capable of managing data communications traffic up to 15 Mbps per copper pair. Modem shall have the capability to support the use of 2-pair data transmission for a maximum transmission speed of 30 Mbps.
c. Each modem shall contain dual Ethernet ports to provide connection to multiple devices when required.
d. Each modem shall have a 24/48 VDC power input slot.

2.7 SERIAL DATA INTERFACING

A. All communicating equipment shall interface to the existing InfoScan system using standard interface protocols as shown on contract drawings. Industry standard interfaces are BACnet-MSTP, BACnet-IP and Modbus RTU.

B. The following categories list the minimum required interface protocol read/write properties:

1. Chiller Requirements (depending upon chiller type)

a. Read Properties:

1) Chiller run status
2) Evaporator leaving water temperature
3) Evaporator entering water temperature
4) Condenser leaving water temperature
5) Condenser entering water temperature
6) Condenser refrigerant pressure
7) Evaporator refrigerant pressure
8) Bearing oil temperature
9) Oil temperature
10) Oil pressure
11) Compressor % RLA.

b. Write Properties:

1) Chiller enable
2) Chiller disable
3) Evaporator leaving water temperature setpoint
4) Percent load setpoint

2. Steam Boiler Requirements

a. Read Properties:

1) Boiler Run Status
2) Low water
3) High water
4) Boiler Alarm

5) Stack Temperature (fuel-fired only)

b. Write Properties:

1) Boiler Enable
2) Boiler Disable
3) Steam Pressure Setpoint

3. Hot Water Boiler Requirements

a. Read Properties:

1) Boiler Run Status
2) Low water
3) High water
4) Water Supply Temperature
5) Water Return Temperature
6) Boiler Alarm
7) Stack Temperature (fuel-fired only)

b. Write Properties:

1) Leaving/Return Water Temperature Setpoint
2) Boiler Enable
3) Boiler Disable

4. Computer Room Air Handling Units

a. Read Properties:

1) Status
2) General Alarm
3) Filter Alarm
4) Temperature
5) Relative Humidity

b. Write Properties:

1) Start/Stop
2) Temperature Setpoint
3) Humidify Setpoint
4) De-Humidify Setpoint

5. Variable Frequency Drive Requirements

a. Read Properties:

1) Frequency

2) Power
3) Motor Current
4) Runtime
5) Fault Alarm

b. Write Properties:

1) Start
2) Stop
3) Frequency Setpoint
4) Minimum Frequency
5) Maximum Frequency
6) Ramp Time
7) Max Current
8) Max Torque

6. Generator Requirements

a. Read Properties:

1) Run Time
2) Engine Temperature
3) Coolant Level
4) Oil Pressure
5) No AC Output Alarm
6) Battery Voltmeter
7) Water Temperature
8) Ammeter
9) Voltmeter
10) Frequency
11) Overcrank Alarm
12) Overspeed Alarm

b. Write Properties:

1) Start/Stop

7. Transfer Switch Requirements

a. Read Properties:

1) Source 1 Power Available Status
2) Source 2 Power Available Status
3) Switch Position Status

b. Write Properties: N/A

8. Electrical Meter Requirements

   a. Read Properties:

      1) KW*
      2) KW (demand)*
      3) KWH
      4) Amps*
      5) Volts*
      6) Neutral Amps*
      7) Power Factor*
      8) THD*
      9) KVA*
      10) KVAR*
      11) KVARHR
      12) Demand Reset
      13) Power Fail Alarm
      14) *Include Min/Max parameters

   b. Write Properties:

      1) Demand Period
      2) Number of Demand Periods
      3) Reset KWH
      4) Reset KVARHR
      5) Reset Min/Max Values

9. Steam Metering Requirements

   a. Read Properties:

      1) Flow Rate
      2) Flow Total
      3) Temperature
      4) Pressure
      5) Peak Rate (time stamped)
      6) Alarm

   b. Write Properties:

      1) Reset Flow Total
      2) Reset Min/Max Values

10 BTU Meter Requirements

   a. Read Properties:

1) Water Flow Rate
2) Water Supply Temperature
3) Water Return Temperature
4) BTU Rate
5) BTU Total

b. Write Properties:

1) Reset BTU Total

11. Un-Interruptible Power-supply (UPS) Requirements

a. Read Properties:

1) Voltage In / Output
2) Current In / Output
3) Battery Voltage
4) Battery Current
5) Runtime
6) Operational Status

b. Write Properties: N/A

12. Electrical Panel with Remote Operable Breaker Requirements

a. Read Properties:

1) Status

b. Write Properties:

1) Breaker Control
2) Zone Control

13. Water Meter Requirements

a. Read Properties:

1) Total
2) Rate

b. Write Properties:

1) Reset Total

14. Thermostat Requirements

a. Read Only Properties:

1) Room Temperature

b. Read/Write Properties:

1) Occupied Heating/Cooling Setpoint
2) Unoccupied Heating/Cooling Setpoint
3) Heating/Cooling Limits
4) System Mode (On/Off/Auto)
5) Fan Mode

15. Gas Detection Requirements

a. Read Properties:

1) Trouble
2) Alarm
3) Gas Level
4) End of Life

b. Write Properties:

1) N/A

16. Lighting Control Systems Requirements

a. Read Properties:

1) Status
2) Zone Occupancy
3) Controller Output

b. Write properties:

1) Zone Override
2) Status
3) Controller Output

PART 3 - EXECUTION

3.1 GENERAL

A. All products shall be installed in accordance with manufacturer's instructions. Installation of control components shall be performed by qualified control and instrumentation specialists. Only penetrations in the bottom of enclosures shall be made unless otherwise specified on contract drawings.

3.2 LOCAL LAPTOP

A. The Government will provide a computer laptop to enable all functions of the UCS system at the building locally. The local laptop will be utilized through all testing and checkout phases, including commissioning. Upon completion of commissioning activities, the Contractor shall return the computer laptop to the Government.

3.3 AC POWER WIRING

A. The Contractor shall install 120 Volt AC power wiring for control system instrumentation if required by device. The breaker must be dedicated to the device and labeled. All work shall be performed in accordance with applicable sections of Division 26, "Electrical," unless otherwise specified. Contact the COR before performing any electrical panel modification.

B. The UCS control panel Uninterruptible Power Source (UPS) input voltage shall be supplied by dedicated 120 volt AC duplex receptacle.

C. 120 volt AC input power cord for field panels shall be of sufficient length to allow connection to either UPS output receptacle or 120 volt AC duplex receptacle dedicated for UPS input.

D. A power disconnect switch shall be provided at each VAV used in the control system and located on the high voltage side of the control transformer.

3.4 EQUIPMENT ACCESSIBILITY

A. Enclosures: Enclosures shall be installed in accordance with the National Electrical Code as a minimum standard. Doors shall not be obstructed and shall open a minimum of 90 degrees from its closed position.

B. Instrumentation: All control system instrumentation shall be installed such that each device is accessible and unobstructed to facilitate ease of maintenance. Examples of obstructed equipment typically include piping surrounding valve actuators and covers that protect electronic components in VAV applications.

1. Outside air reference tubing shall be ¼ inch tubing up to 50 foot maximum, distances greater than 50 foot will require 3/8 inch tubing. Room static pressure sensor shall be directly mounted to wall or standard electrical box 1 foot below finished ceiling.

C. Shelf for Uninterruptible Power Sources (UPS) shall be constructed of corrosion-resistant metal of sufficient gauge to support UPS weight without flexing with a 3/8-inch minimum lip around edge. Shelf shall be mounted beneath field panel and 6 inches minimum above finished floor.

D. Wall Mounted Sensors: Wall mounted space sensors shall be mounted at a height of 54 inches from center of sensor to above finished floor or grade. Sensors shall be mounted on an interior wall opposite exterior walls and windows. Do not locate behind door

swings or furniture. Sensors shall be sealed/insulated from behind to avoid drafts from conduit and wall penetrations. Sensors mounted on block walls shall be offset with an insulating spacer to separate the sensor from direct wall contact. Sensor examples include, but are not limited to, temperature, humidity and indoor air quality.

3.5 VIBRATION ISOLATION

A. Controllers and other devices sensitive to vibration shall be isolated by location or utilizing shock absorbing mounting devices.

3.6 SEQUENCE OF OPERATION

A. The sequence of operation shall be as indicated on the design drawing(s). All changes to the Sequence of Operation shall be noted on the as-built drawings.

3.7 CONTROL SYSTEM DRAWINGS

A. At completion of the job, the Contractor shall furnish copies of as-built wiring diagrams, system schematics, and sequences of control. One (1) copy of each shall be enclosed in laminated plastic, suspended at each air handler and/or controlled system and inside each control panel, or as directed by the Contracting Officer's Representative (COR).

B. Wiring diagrams shall show all instrumentation, interlocks and connection information required for controlling the specified equipment.

3.8 SYSTEM VERIFICATION AND STARTUP

A. Verification testing shall be performed in the presence of the Government Construction Management Inspector (or CA in the case of commissioned equipment) and shall be repeated, as necessary, until each system or control loop is successfully verified.

B. The Contractor shall have factory-authorized representatives perform system start-up and adjustment after acceptance of test plans.

C. The Contractor shall demonstrate to the Government through a system verification test that final calibrations and adjustments are accurate and each control loop operates as defined by the sequence of operation. All deficiencies shall be corrected prior to final acceptance. The Government Construction Management Inspector (or CA in the case of commissioned equipment) shall witness all verification tests.

D. The Controls Contractor shall perform a complete checkout and verification of the controls and instrumentation before total system commissioning begins. The Controls Contractor shall participate in the total integrated system commissioning. Integrated system commissioning procedures are specified in Section 01 91 13, “General Commissioning Requirements.”

3.9 NETWORK DISTRIBUTION LABELING

A. Labeling shall conform to ANSI/TIA/EIA606(A) standards. In addition, provide the following:

1. Label each outlet with permanent self-adhesive label with minimum 3/16 in. high characters.
2. Label each end of cable with permanent self-adhesive label with minimum 1/8 in. high characters.
3. Provide facility assignment records in a protective cover at each telecommunications closet location that is specific to the facilities terminated therein.
4. Labels shall be machine-printed. Hand-lettered labels shall not be acceptable.
5. Label cables, outlets, patch panels, and punch blocks with the designation shown on drawings.

3.10 NETWORK DISTRIBUTION TESTING

A. Testing shall conform to ANSI/TIA/EIA568B.1 standard. Testing shall be accomplished using level IV or higher field testers.

B. Test each pair and shield of each cable for opens, shorts, grounds, and pair reversals. Correct grounded and reversed pairs. Examine open and shorted pairs to determine if problem is caused by improper termination. If termination is proper, tag bad pairs at both ends and note on termination sheets.

1. Perform testing of copper cables with tester meeting ANSI/TIA/EIA568B.1 requirements.
2. If copper cables contain bad pairs, or if outer sheath damage is cause of bad pairs, remove and replace entire cable.
3. If horizontal cable contains bad conductors or shield, remove and replace cable.

C. Initially test fiber optic cable with a light source and power meter utilizing procedures as stated on ANSI/TIA/EIA52614A: OFSTP14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant and ANSI/TIA/EIA5267 Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant. Measured results shall be plus/minus 1 dB of submitted loss budget calculations. If loss figures are outside this range, test cable with optical time domain reflectometer to determine cause of variation. Correct improper splices and replace damaged cables at no charge to the owner.

1. Cables shall be tested at 850 and 1300 nm for multimode optical fiber cables. Cables shall be tested at 1310 and 1550 nm for singlemode optical fibers.
2. Testing procedures shall utilize “Method B”-One jumper reference.
3. Bi-directional testing of optical fibers is required.

D. Perform optical domain reflectometer (OTDR) testing on each fiber optic conductor. Measured results shall be plus/minus 1 dB of submitted loss budget calculations.

1. Submit printout for each cable tested.
2. Submit compact disk with test results and program to view results.

E. Where any portion of system does not meet the specifications, correct deviation and repeat applicable testing at no additional cost to the owner.

3.11 TRAINING

A. The Contractor shall provide 2 identical complete on-site instruction Session(s) for approximately 10 personnel. Each session shall consist of a minimum of 8 hours. Instructors shall be factory-authorized representatives. The government shall approve course content and format.

END OF SECTION 23 09 23

SECTION 26 05 01 – ELECTRICAL WORK, INTERIOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including other Specification Sections, apply to this Section.

1.2 GENERAL

A. This section shall apply to all work involving existing buildings and structures as well as new. All work done in and around existing buildings shall meet the requirements of this section and other sections as apply.

B. Rules: The installation shall conform to the requirements of NFPA 70 (2014) and NFPA 101 (2012) unless more stringent requirements are indicated or shown herein or in the drawing set.

C. Coordination: The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be located to avoid interference with mechanical or structural features; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Electrical Contractor shall coordinate the electrical work with HVAC and electrical drawings and provide all power related wiring even if they are not shown on electrical drawings.

D. Standard Products: Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

E. Identification Nameplates: Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, all identification nameplates shall be made of laminated plastic with black outer layers and a white core. Edges shall be chamfered. Except on motors nameplates shall be fastened with black-finished round -head drive screws or approved non-adhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate

shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The following equipment, as a minimum shall be provided with identification nameplates:

Minimum 1/4-Inch High Letters	**Minimum 1/8-Inch High Letters**
Panelboards	Control Power Transformers
Starters	Control Devices
Safety Switches	Instrument Transformers
Transformers	
Equipment Enclosures	

F. Record Drawings: Following the project completion or turnover, within 30 days the Contractor shall furnish two sets of record drawings to the Contracting Officer.

1.3 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 “Submittal Procedures” in sufficient detail to show full compliance with the Contract Documents:

B. Drawings

1. Electrical Work: Detail drawings for the station control house including all materials and equipment specified. Detail drawings shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical data; catalog cuts; and any special installation instructions that may be required. Drawings shall show building wiring layout, applicable schematic diagrams; and equipment layout and anchorage; and conduit and cable tray runs, anchorage, and support. Telephone system drawings showing actual layout, including conduit locations, type any gauge of cables, and terminal assignment of wiring, after installation.

C. Reports

1. Materials and Equipment: The label or listing of the Underwriters Laboratories, Inc., shall be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Materials and equipment shall be approved based on the manufacturer's published data.
2. For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable

Federal Specification, or standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

D. Workmanship: Materials and equipment shall be installed in accordance with recommendations of the manufacturer and as shown.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section.

B. Cables and Wires: Conductors in cables shall be annealed copper. Intermixing of copper and aluminum conductors is not permitted. Design is based on copper conductors. Cables shall be single -conductor type, unless otherwise indicated. Cables and wires shall conform to UL 44 (2014) for rubber-insulated type; UL 83 (2014) for the thermoplastic -insulated type; and UL 719 (2006) for the nonmetallic -sheathed cables. The following types shall be provided.

1. Service Entrance Cable: Type SE USE.
2. Grounding Cables: Grounding cables shall be bare or shall have green low-voltage insulation.
3. Cord Sets and Power-Supply Cords: UL 817 (2001).
4. Cable Trays: Cable trays shall form a wire-way system, and shall be of nominal 4-inch depth. Cable trays shall be constructed of aluminum or steel that has been zinc-coated after fabrication. Trays shall include splice and end plates, dropouts, and miscellaneous hardware. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Fittings shall have not less than the load-carrying ability of straight tray sections and shall have manufacturer's minimum standard radius unless otherwise indicated.
5. Trough: Trough-type cable trays shall be of a nominal 12-inch width or as required.
6. Ladder: I Ladder-type cable trays shall be of nominal 12-inch width. Rung spacing shall be on 6- inch maximum centers or as required.
7. Channel: Channel-type cable trays shall be of 4-inch width or as required. Trays shall be one- piece construction having slots spaced not more than 4-1/2 inches on centers.
8. Cantilever: Cantilever-type, center-hung cable trays may be provided at the Contractor's option in lieu of other cable tray types specified.

C. Cabinets for Communications: UL 50 (2007). Cabinets shall have boxes constructed of zinc-coated sheet steel. Cabinets shall be constructed with interior dimensions not less than those indicated. Trim shall be fitted with hinged door and flush catch. Doors shall provide maximum-size openings to the box interiors. Boxes shall be provided with a 5/8-inch plywood backboard having a two -coat insulating varnish finish.

D. Circuit Breakers: Circuit breakers shall have voltage, current and interrupting ratings as

indicated. Fully rated circuit breakers shall be provided as indicated, for specific pieces of distribution equipment, to obtain the specified interrupting rating.

1. Molded-Case and Insulated-Case Circuit Breakers: UL 489 (2013) for circuit breakers. Molded-Case Circuit Breakers: Molded-case circuit breakers shall be bolt-on type, plug-on breakers are not acceptable. Single -pole breakers shall be full module size; tandem breakers (two breakers in one module) shall not be used. Multi-pole breakers shall be of the common-trip type having a single operating handle, but for sizes of 100 amperes or less may consist of single -pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, non-tamper-able common-trip mechanism and external handle ties. Breakers shall have interchangeable, adjustable magnetic, trips in 225 amperes frame and larger. Breakers coordinated with current-limiting fuses shall have a combined interrupting capacity of 100,000 symmetrical amperes. All poles of associated breakers shall open if any fuse blows.
2. Ground Fault Circuit Interrupters: UL 943 (2006). Breakers equipped with ground fault interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.

E. Conduit and Tubing: Electrical, Zinc-Coated St eel Metallic Tubing (EMT) UL 797 (2007).

1. Electrical Plastic Tubing and Conduit: NEMA TC 2 (2013).
2. PVC Coated Rigid Steel Conduit: NEMA RN 1 (2013).
3. Rigid Metal Conduit: UL 6 (2007).
4. Rigid Plastic: NEMA TC 2 (2013), UL 651(2011) and UL 651A (2011). Conduit and Device Boxes and Fittings
5. Boxes, Metallic Outlet: NEMA OS 1 (2013) and UL 514A (2013).
6. Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers: NEMA OS 2 (2013) and UL 514C (2014).
7. Boxes, Switch (Enclosed), Surface-Mounted: UL 98 (2004).
8. Fittings for Conduit and Outlet Boxes: UL 514B (2012).
9. Fittings, PVC, for Use with Rigid PVC Conduit and Tubing: UL 514B (2012).

F. Connectors, Wire Pressure

1. Copper Conductors: UL 486A (2013).
2. Aluminum Conductors: UL 486B (2013).

G. Electrical Grounding and Bonding Equipment: UL 467 (2013).

1. Ground Rods: Ground rods shall be of copper-clad steel conforming to UL 467 (2013) not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

H. Enclosures: NEMA ICS 6 (2011)or NEMA 250 (2007).

1. Cabinets and Boxes: UL 50 (2007).
2. Circuit Breaker: UL 489 (2013).

I. Fixtures, Lighting and Fixture Accessories/Components: Fixtures, accessories and components, including ballasts, lamp holders, lamps, starters and starter holders, shall

conform to industry standards specified below.

1. Fixture, Auxiliary or Emergency: UL 924 (2006).
2. Incandescent Fixture: NEMA LE 4 (2012) for ceiling compatibility of recessed fixtures and UL 1598 (2008).
3. Fluorescent

    a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1598 (2008)
    b. Ballast High-Power Factor, Class P, Automatic -Resetting Type: NEMA C82.1 (2004) and UL 935 (2001).
    c. Lamp holders, Starters, and Starter Holders: UL 542 (2005).

J. Fuses and Fuse holders

1. Fuses, Low Voltage Cartridge Type: NEMA FU 1 (2012).
2. Fuses, Class CC: UL 248-4 (2000).
3. Fuses, Class G: UL 248-5 (2000)
4. Fuses, Class H, Non-Renewable: UL 248-6 (2000).
5. Fuses, Class J: UL 248-8 (2000).
6. Fuses, Class K: UL 248-9 (2000).
7. Fuses, Class L: UL 248-10 (2000).
8. Fuses, Plug Type: UL 248-11 (2011).
9. Fuses, Class R: UL 248-12 (2011).
10. Fuses, Semi-Conductor Type: 248-13 (2000).
11. Fuses, Supplemental Type: UL 248-14 (2010).
12. Fuses, Class T: UL 248 -15 (2010).
13. Fuse holders: UL 4248- 11 (2007), UL 4248-12 (2007) and UL 4248-15 (2007).

K. Panel-boards: Dead-front construction, NEMA PB 1 (2011) and UL 67 (2009).

L. Receptacles

1. Standard Grade: UL 498 (2012).
2. Ground Fault Interrupters: UL 943 (2006), Class A or B.

M. Service Equipment: UL 869A (2006).

N. Splice, Conductor: UL 486C (2013).

O. Snap Switches: UL 20 (2010).

P. Tapes

1. Plastic Tape: UL 510 (2005).
2. Rubber Tape: UL 510 (2005).

Q. Transformers

1. Conventional Dry -Type: IEEE C57.12.01 (2005), IEEE C57.12.10 (2010), IEEE C57.12.80 (2010), IEEE C57.12.91 (2011), IEEE C57.94 IEEE C57.98, IEEE

C57.105 (2008) and UL 1561 (2011) in addition to the specific standards' referenced below.

a. Specialty or General Applications: NEMA ST 20 (2014) and UL 506 (2008) unless otherwise shown or specified.
b. Instrument: NEMA C12.11 (2014) and IEEE C57.13 (2008) with current ratio or voltage ratings shown or specified.

R. Wiring Devices: NEMA WD 1 (2010) for general-purpose wiring devices, and NEMA WD 6 (2012) for dimensional requirements of wiring devices.

PART 3 - EXECUTION

3.1 GROUNDING

A. Grounding shall be in conformance with NFPA 70 (2014), the contract drawings, and then following specifications.

B. Ground Rods: The resistance to ground shall be measured using the fall-of-potential method described in IEEE 81 (2012). The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods not less than 6 feet on centers, or if sectional type rods are used, additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

C. Grounding Conductors: A Green ground wire shall be furnished regardless of the type of conduit. All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Insure that all metallic raceways and grounding conductors are actually wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70 (2014). When boxes for receptacles, switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

3.2 WIRING METHODS

A. General Requirements: Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid galvanized steel conduit, rigid plastic conduit, or electrical metallic tubing.

B. Cable Trays: Cable trays shall be supported in accordance with the recommendations of the manufacturer but at no more than 6-foot intervals. Contact surfaces of aluminum connections shall be coated with an antioxidant compound prior to assembly. Adjacent

cable tray sections shall be bonded together by connector plates of an identical type as the cable tray sections. The Contractor shall submit the manufacturer's certification that the cable tray system meets all requirements of Article 336 of NFPA 70 (2014). The cable tray shall be installed and grounded in accordance with the provisions of Article 336 of NFPA 70 (2014). Data submitted by the Contractor, in compliance with submittal SD-04 Detailed Drawings, shall demonstrate that the completed cable tray systems will comply with the applicable publications referenced in paragraph REFERENCES and in paragraph MATERIALS AND EQUIPMENT.

C. Conduit and Tubing Systems: Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 3/4 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or then required by conformance to NFPA 70 (2014). Nonmetallic conduit and tubing may be used in damp, wet or in corrosive locations when permitted by NFPA 70 (2014) and the conduit or tubing system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Electrical metallic tubing may be installed only within buildings. Electrical metallic tubing may be installed in concrete and grout in dry locations. Electrical metallic tubing installed in concrete or grout shall be provided with concrete tight fittings. EMT will not be installed in damp or wet locations. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70 (2014). Only UL listed adapters shall be used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies. Penetrations of above grade floor slabs, time-rated partitions and firewalls shall be fire-stopped in accordance with code requirements. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding. Wiring installed in under floor duct system under floor raceway system shall be suitable for installation in wet locations.

1. Below Slab-on-Grade or in the Ground: All electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel. Rigid steel conduits installed below slab-on-grade or in the earth shall be field -wrapped with O.010 -inch thick pipe-wrapping plastic tape applied with a 5O-percent overlay, or shall have a factory -applied polyvinyl chloride, plastic resin, or epoxy coating system.
2. Installing in Slabs Including Slabs on Grade: Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than three diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer.
3. Exposed Raceways: Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 (2014) definitions.
4. Changes in Direction of Runs: Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed

raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed of obstructions or shall be replaced.

5. Supports: Metallic conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, or ceiling trapeze . C-clamps or beam clamps shall have strap or rod-type retainers. Rigid plastic conduits (if permitted as a wiring method) shall be supported as indicated above, except that they will be supported at intervals as indicated in NFPA 70 (2014). Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4-inch in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Conduit shall not be supported using wire or nylon ties. Raceways shall be installed as a complete system and be independently supported from the structure. Upper raceways shall not be the support of lower raceways. Supporting means will not be shared between electrical raceways and mechanical piping or ducts and shall not be fastened to suspended ceiling supports. Conduits shall be fastened to all sheet-metal boxes and cabinets with two locknuts where required by the NFPA 70 (2014), where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Thread-less fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. A pull wire shall be inserted in each empty raceway in which wiring is to be installed by others if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be No. 14 AWG zinc- coated steel or plastic having not less than 200-pound tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire. Additional support for horizontal runs is not required when EMT rests on steel stud cutouts.
6. Exposed Risers: Exposed risers in wire shafts of multistory buildings shall be supported by U- clamp hangers at each floor level, and at intervals not to exceed 10 feet.
7. Exposed Lengths of Conduit, Over 600 Volts: Exposed lengths of conduit containing power conductors operating at more than 600 volts shall have two red bands 2 inches wide spaced 8 inches apart painted near each coupling; the intervening space between the red bands shall be painted white, and on the white space the voltage shall be stenciled in black: "xxxxx" volts ("xxxxx" is actual voltage).
8. Communications Raceways: Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and

with the additional requirements that no length of run shall exceed 50 feet for 3/4-inch sizes, and 100 feet for 1-inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1-inch size or larger shall be not less than ten times the nominal diameter.

D. Cables and Conductors: Aluminum conductors are restricted to open overhead applications. All other conductors shall be copper. Wire connectors of insulating material or solderless pressure connectors properly taped shall be utilized for all splices. Pressure connectors for aluminum conductors shall have tinned aluminum bodies. Aluminum contact surfaces of conductors and connectors shall be cleaned and covered with antioxidant compound prior to making of connections.

1. Sizes: All sizes are based on copper conductors, unless otherwise indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. The conductor sizes are based on the use of TW insulation for conductors smaller than No. 1/0 AWG and THW insulation for conductors No. 1/0 and larger, except where otherwise indicated. Higher temperature rated conductors shall be permitted to be used if the UL tested temperature ratings for which the equipment in the circuit is marked are not exceeded. Conductor sizes for nonlinear loads shall be based on the use of minimum 75 degrees C insulated conductors for branch circuits and feeders.
2. Power Conductor Identification: All phase conductors shall be identified by color-coding. The color of the insulation on the phase conductors of different voltage systems shall be as follows:

120/208 Volt, Three-Phase:	Black, Red, and Blue
250 Volt, DC:	Orange and Yellow
120/240 Volt, Single-Phase:	Black and Red

3. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than Number 6 AWG. For conductors Number 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.
4. Control Conductor Identification: Control circuit conductor identification shall be made by plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. Control circuit terminals of equipment shall be properly identified. Terminal and conductor

identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3.3 BOXES AND SUPPORTS

A. Boxes shall be provided in the wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways, 4-inch by 4-inch nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces, or when located in hazardous areas. Large size boxes shall be NEMA 1, or 3R or as shown. Boxes in other locations shall be sheet steel, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic -sheathed cable system, when permitted by IFPA 70 (2014). In partitions of light steel construction bar hangers with 1-inch long studs, mounted between metal wall studs or metal stud "C" brackets snapped on and tab-locked to metal wall studs, shall be used to secure boxes to the building structure. When "C" brackets are used, additional box support shall be provided on the side of the box opposite the brackets. The edges of boxes for electrical devices shall be flush with the finished surfaces in gypsum and plasterboard installations. Boxes for mounting lighting fixtures shall be not less than 4-inches square except smaller boxes may be installed as required by fixture configuration, as approved. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry - block walls for concealed wiring shall be flush with the top of a block to minimize cutting of blocks, and boxes shall be located horizontally to avoid cutting webs of block. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70 (2014). Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Cast- metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided. Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Threaded studs driven in by powder charge and provided with lock washers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. In open overhead spaces, cast- metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Cast-metal boxes with 3/32 -inch wall thickness are acceptable. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box. Penetrations into reinforced-concrete beams or into reinforced-concrete joists shall avoid cutting any reinforcing steel.

B. Boxes for Use with Raceway Systems: Boxes for use with raceway systems shall be not less than 1-1/2 inches deep except where shallower boxes required by structural conditions are approved. Sheet metal boxes for other than lighting fixtures shall be not less than 4 inches square except that 4- by 2-inch boxes may be used where only one

raceway enters the outlet. Contractor shall size the telephone outlet boxes as required by the number, size and type of outlets specified and as required by the outlets furnished by the Contractor.

C. Boxes for Use with Cable Systems: Boxes for use with cable systems shall be not less than 3-inch by 2-inch sectional boxes, 2-inches deep.

D. Pull Boxes: Pull boxes of not less than the minimum size required by the NFPA 70 (2014) shall be constructed of galvanized sheet steel, except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastened covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

E. Conduit Stub-Ups: Conduits stubbed up through concrete floors for connections to freestanding equipment shall be provided with a short elbow and an adjustable top or coupling threaded inside for plugs, set flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Screwdriver operated threaded flush plugs shall be installed in conduits from which no equipment connections are made to suit the devices installed.

3.4 DEVICE PLATES

A. One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast-metal or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be of steel with baked enamel finish or impact-resistant plastic and shall be ivory. Plates on finished walls shall be of satin finish corrosion resistant steel or of satin finish chromium plated brass. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permit ted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

3.5 RECEPTACLES

A. Single and Duplex: Single and duplex receptacles shall be rated 20 amperes, 125 volts, two -pole, three- wire, grounding type with polarized parallel slots. Bodies shall be of brown or ivory to match color of switch handles in the same room or to harmonize with the color of the respective wall, and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back- wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application. Receptacles

with ground fault circuit interrupters shall have the current rating as indicated, and shall be the UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided everywhere as required by the National Electrical Code and in addition all the following receptacle locations; exterior including those on roofs, bathrooms with showers, shops, hangars, and garages.

B. Weatherproof: Weatherproof receptacles shown shall be mounted in a box with a gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. The cap shall be permanently attached to the cover plate by a short length of bead chain shall be provided with a spring- hinged flap.

C. Receptacles, 15-Ampere, 250-Volt: Receptacles, 15-ampere, 250-volt, shall be single duplex two-pole, three-wire, grounding tie with bodies of brown ivory phenolic compound supported by mounting yoke having plaster ears. The third grounding pole shall be connected to the metal yoke. Each receptacle shall be provided with a mating cord -grip cap.

D. Receptacles, 20 -Ampere, 250 -Volt: Receptacles, single, 20-ampere, 250-volt, shall be molded plastic, two -pole, three-wire or three-pole, four-wire, grounding type complete with appropriate mating cord -grip plug.

E. Receptacles, 30-Ampere, 125/250-Volt: Receptacles, single, 30 ampere, 125/250-volt, shall be molded-plastic, three-pole, three-wire type with ground, complete with appropriate matching cord-grip type attachment plug.

F. Receptacles, 30-Ampere, 250-Volt: Receptacles, single, 30-ampere, 250-volt, shall be molded-plastic, three-pole, three-wire type with ground, complete with appropriate mating cord -grip plug.

3.6 WALL SWITCHES

A. Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall harmonize with the color of the respective wall. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single -gang position. Switches shall be rated 20-ampere 277-volt for use on alternating current only or 250V DC as required. Pilot lights indicated shall consist of yoke -mounted candelabra -base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6 -watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red.

3.7 SERVICE EQUIPMENT

A. Service-disconnecting means shall be of the enclosed molded-case circuit breaker with external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

3.8 PANELBOARDS

A. Circuit breakers and switches used as a motor disconnecting means, and not in sight of the motor and the driven machinery location, shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper.

B. Panelboards: Panelboards shall be circuit breaker equipped.

3.9 FUSES

A. Equipment provided under this contract shall be provided with a complete set of properly rated fuses. The fuses installed shall comply with the equipment manufacturer specifications for fuse size and type and/or shall meet or exceed any requirement to limit available fault current in the protected circuit. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time - current characteristics required for effective power system coordination.

B. Plug Fuses: Plug fuses shall be of the nonrenewable time -delay type and shall be used for circuits rated 125 volts or less and 30 amperes or less.

C. Cartridge Fuses; Noncurrent-Limiting Type: Cartridge fuses of the non-current-limiting type shall be Class H, nonrenewable, dual element, time lag type and shall have interrupting capacity of 10,000 amperes. At 500 percent current, cartridge fuses shall not blow in less than 10 seconds. Cartridge fuses shall be used for circuits rated in excess of 30 amperes, 125 volts, except where current-limiting fuses are indicated.

D. Cartridge Fuses; Current-Limiting Type: Cartridge fuses, current-limiting type, Class G, J, L, RK1, RK5, RK9, T, and CC, shall have tested interrupting capacity not less than 100,000 amperes. Fuse-holders shall be the type that will reject all Class H fuses.

3.10 UNDERGROUND-SERVICE CONDUITS

A. Empty conduits for underground electric -service cable and telephone cable shall be installed as indicated. Conduits shall terminate approximately where shown (or as directed) 2 feet below finished grade, with the outside ends bushed and plugged or capped.

3.11 AERIAL SERVICE

A. Aerial power-service entrance conductors which originate at a power-supply transformer shall be rigidly supported from an approved type of malleable -iron structural support specifically designed and manufactured for the application, and for mounting to an exterior wall. The service-entrance conductors shall be continuous between the power-supply transformer and the service-entrance meter enclosure equipment and shall be routed from the structural support to a weatherhead, or weatherproof conduit fitting, before entry into an enclosing conduit. At least 4 feet of slack shall be provided in the

service- entrance conductors, which shall be formed to provide a drip -loop, between the structural support and the weatherproof conduit fitting. The weatherproof service-entrance fitting shall be securely fastened to a rigid -galvanized steel (RGS) conduit that shall be terminated in the meter enclosure service-entrance equipment which penetrates the exterior wall roof. Penetration of the conduit through an exterior wall shall be sealed in an approved manner to prevent the entrance of moisture, and the escape of conditioned air. An approved roof-penetration fitting shall be provided for the conduit to prevent the entrance of rain. Service-entrance conductors shall be routed in RGS in the exterior wall, or in the interior of the building or facility that contains the meter enclosure service-entrance equipment.

3.12 MOTOR-DISCONNECT MEANS

A. Each motor shall be provided with a disconnecting means when required by NFPA 70 even if such is not indicated on the drawings. For fractional horse power, single -phase motors, a single - or double -pole, motor rated, toggle switch, rated only for alternating current, will be acceptable, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3.13 TRANSFORMERS

A. Only single -and three-phase transformers having two windings per phase will be approved. Full capacity standard NEMA taps shall be provided in the primary windings of transformers having a primary rating in excess of 600 volts. Three-phase transformers shall be connected only in a delta-wye or wye-delta configuration, as indicated except isolation transformers having a one-to-one turns ratio. "T" connections may be used for transformers rated at 15 kVA or below. The insulation on transformer windings may be the manufacturer's standard for transformers rated for operation in a 40-degree Celsius ambient temperature unless a higher-temperature insulation is shown, specified or required by the application indicated. Single kVA ratings shown are based on self-cooled operation. The basic impulse level (BIL) of individual transformers shall be as stated in the following paragraphs. Transformers to be located within the building and vault may be provided in the manufacturer's standard, ventilated indoor enclosure designed for use in a 40-degree Celsius ambient temperature, unless otherwise specified or shown. The average sound level in decibels (dB) of transformers shall not exceed the following dB level for the applicable kVA rating range listed:

KVA Range	dB Sound Level
1-50	50
51-150	55
151-300	58
301-500	60

B. Conventional Dry -Type Transformers: Transformers having the primary or higher-voltage winding rated at 600 volts or less and a secondary or lower-voltage winding rated at 240 volts or less may be manufacturer's standard ventilated or enclosed, self-cooled type of transformer unless otherwise shown, specified or required for proper and safe application.

3.14 LAMPS AND LIGHTING FIXTURES

A. Ballasted fixtures shall have ballasts which are compatible with the specific type and rating of lamps indicated and shall comply with the applicable provisions of the publications referenced.

B. Lamps: Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project.

1. Incandescent: Incandescent lamps shall not be used.
2. Fluorescent: Fluorescent lamps shall have standard cool-white color characteristics and shall be of a type that will not require starter switches. Lamps shall be rapid -start T-8 unless otherwise shown or approved.

C. Fixtures: Fixtures shall be as shown and shall conform to the following specifications for the types indicated. Illustrations shown on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs, equivalent energy efficiency, light-distribution, and brightness characteristics, and of equal finish and quality will be acceptable if approved.

1. Accessories: Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation. Open type fluorescent fixtures with exposed lamps shall have a wire - basket type guard.
2. Suspended Fixtures: Suspended fixtures shall be provided with swivel hangers in order to ensure a plumb installation. Pendants rods or chains 4 feet or longer excluding fixture, shall be braced to limit swinging. Bracing shall be 3 directional 120 degrees apart. Single -unit suspended fluorescent fixtures shall have thin stem hangers. Multiple -unit or continuous -row fluorescent units shall have a tubing or stem for wiring at one point, and a tubing or rod suspension provided for each length of chassis including one at each end. Maximum distance between adjacent tubing or stems shall be 10 feet. Rods shall be of not less than 3/16-inch diameter. Flexible raceway shall be installed to each fixture from an overhead junction box. Fixture to fixture wiring installation is allowed only when fixtures are installed end to end in a continuous run.

D. Emergency Light Sets: Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

3.15 EQUIPMENT CONNECTIONS

A. All wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid -tight conduits shall be used in damp or wet locations.

3.16 MOTORS AND MOTOR CONTROL

A. Control equipment furnished under this section of the specifications, and shown on the drawings, shall be connected under this section of the specifications unless shown or specified otherwise. Except as otherwise specifically noted, automatic -control wiring, signaling, and protective devices are not included in this section of the specifications, but shall be furnished and installed under other sections of the specifications. Control wiring not shown on the drawings shall be furnished under the other sections of the specifications.

3.17 PAINTING AND FINISHING

A. Field -applied paint on exposed surfaces shall be provided as required and approved, shall meet standards of good practice for application, and shall match existing conditions where applicable.

3.18 REPAIR OF EXISTING WORK

A. The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surface is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved, at no additional cost to the Government.

3.19 TESTS

A. All tests required must be coordinated with and witnessed by COR.

B. After the interior-wiring-system installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. Continuity test shall be conducted on the wiring system. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish all instruments and personnel required for the tests, and the Government will furnish the necessary electric power. No part of the electrical distribution system shall be energized prior to the resistance testing of that systems ground rods and

submission of test results to the Contracting Officer. Test reports shall indicate the location of the rod and the resistance and the soil conditions at the time the test was performed.

END OF SECTION 26 05 01

SECTION 26 05 43 – ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including other sections of this specification shall sections shall apply to this Section.

1.2 GENERAL REQUIREMENTS

A. Terminology: Terminology used in this specification is as defined in IEEE 100 CD (2009).

B. Code Compliance: The installation shall comply with the requirements and recommendations of NFPA 70 (2014) and ANSI C2 (2012).

C. Nameplates: Each major component of equipment shall have as a minimum the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and shall be provided on each item of equipment. Transformer nameplates shall be permanently marked and state that the transformer dielectric to be supplied is non-PCB classified with less than 1 part per million (ppm) PCB content.

D. Prevention of Corrosion: Metallic Materials - Metallic materials shall be protected against corrosion as specified. Aluminum shall not be used.

E. Unusual Service Conditions: Items furnished under this section shall be specifically suitable for the following unusual service conditions:

1. Seismic Category C, Importance Factor 1.

F. Verification of Dimensions: The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.3 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 “Submittal Procedures” in sufficient detail to show full compliance with the Contract Documents:

B. Data: A Short Circuit and Protective Device Coordination Study shall be prepared and submitted for all protective devices included in this section in accordance with Paragraph 1.2.G of SECTION 16 11 13, MAIN ELECTRIC SUPPLY STATION.

1. Manufacturer's Catalog Data: Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

2. Material, Equipment, and Fixture Lists: A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.
3. Installation Procedures: As a minimum installation procedure for sectionalizing cabinets, medium-voltage cable terminations and splices. Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

C. Drawings

1. Underground Electrical Distribution System

a. Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.
b. If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government. Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:
c. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.
d. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.
e. Detail drawings shall, as a minimum, depict the installation of the following items:

1) Medium-voltage cables and accessories including cable installation plan.
2) Pad-mounted Sectionalizing Enclosures

D. Tests

1. Factory Test: Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted

within 7 days following successful completion of the tests specified in applicable publications or in these specifications. The manufacturer's pass -fail criteria for tests specified in paragraph FIELD TESTING shall be included.

2. Field Testing: Submit a proposed field test plan for approval prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.
3. Test Reports: Six copies of the information described below in 8 1/2 by 11 inch binders having a minimum of 5 rings from which material may readily be moved and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

    a. A list of all equipment used, with calibration certifications.
    b. A copy of all measurements taken.
    c. The dates of testing.
    d. The equipment and values to be verified.
    e. The condition specified for the test.
    f. The test results, signed and dated.
    g. A description of all adjustments made.

4. Cable Installation Reports: Six copies of the information described below in 8 1\2 by 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

    a. Site layout drawing with all cable pulls numerically identified.
    b. A list of all equipment used, with calibration certifications.
    c. The manufacturer of and quantity of lubricant used on pull.
    d. The cable manufacturer and type of cable.
    e. The dates of cable pulls, time of day, and ambient temperature.
    f. The length of cable pulls and calculated cable pulling tensions.
    g. The actual cable pulling tensions encountered during pull.

E. Certificates

1. Materials and Equipment: Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided under this section of the specifications conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a

recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

2. Cable Splicer Qualification: A certification that contains the names and the qualifications of people recommended to perform the splicing and termination of medium-voltage cables approved for installation under this contract. The certification shall indicate that any person recommended to perform actual splicing and terminations has been adequately trained in the proper techniques and have had at least three recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, any person recommended by the Contractor may be required to perform a practice splice and termination, in the presence of the Contracting Officer, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.
3. Cable Installer Qualifications: The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

F. Operation and Maintenance Manuals

1. Electrical Distribution System: Submit operation and maintenance manuals for underground distribution system and all components thereof as required by Section 01 78 20, “Operation and Maintenance Data.”

1.4 DELIVERY, STORAGE, AND HANDLING

A. Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ASC/05 05.1 (2008). Handling of wood poles shall be in accordance with ASC/05 05.1 (2008), except that pointed tools capable of producing indentations more than 1 inch in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

1.5 EXTRA MATERIALS

A. One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable toolbox. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2 - PRODUCTS

2.1 STANDARD PRODUCT

A. Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 NAMEPLATES

A. General: Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. Sectionalizer switch nameplates shall have a schematic with all witch positions shown and labeled. As a minimum, nameplates shall be provided for transformers, circuit breakers, meters, switches, and switchgear.

2.3 CORROSION PROTECTION

A. Aluminum Materials: The use of aluminum as an electrical conductor is limited to open, overhead construction consisting of either ACSR wire or extruded or rolled shapes listed for use as electrical bus. Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B- shall be used.

B. Ferrous Metal Materials

1. Conduit and Hardware: Ferrous metal conduit and hardware shall be hot -dip galvanized in accordance with ASTM A 153 (2009) and ASTM A 123 (2013).
2. Junction & Splice Boxes: Junction and Splice boxes and other associated parts of conduit systems shall be hot dip galvanized in accordance with ASTM A 153 (2009) and ASTM A 123 (2013).
3. Equipment: Equipment and component items, not otherwise specified elsewhere, including but not limited to metering cabinets and ferrous metal luminaries, not hot -dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 480 hours of exposure to the salt spray test specified in ASTM B 117 (2011) without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 (2008) with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.4 CABLES

A. Cables shall be of annealed copper. Intermixing of copper and aluminum conductors is

not permitted, except at connections to conductors not provided under this contra ct. Design is based on copper conductors. Cables shall be single -conductor type, unless otherwise indicated.

B. Low-Voltage Cables: Low-voltage cables shall have 600 volt insulation, shall conform to UL 854 (2004) for Type USE service entrance cable, and shall utilize either cross-linked, thermosetting-polyethylene or ethylene-propylene-rubber insulation.

C. Medium-Voltage Cables: This specification covers the requirements for 15 kV ethylene propylene rubber (EPR) insulated power cable with concentric neutral and PVC jacket. The cable is intended for use on the 12.5/7.2 kV underground distribution systems with solidly grounded neutral. Cables shall be single conductor shielded power cable with 33% (100% for 1 phase) ampacity jacketed concentric neutral, suited for use on a grounded neutral circuit not exceeding 15 kV phase to phase with 133% insulation level. The cable is intended for underground distribution application and shall be suitable for installation in wet or dry locations, in intermittent or continuous submersion in water, and in metallic or non-metallic ducts. The cable shall be capable of operating at a conductor temperature of 90 degrees C continuously, at 130 degrees C under emergency overload conditions, and shall tolerate 250 degrees C under short circuit conditions.

1. Conductor: Conductor and Concentric neutral wires shall be soft or annealed coated or uncoated copper wire with concentric lay Class B round stranding, in accordance with ASTM B8 (2011) and B33 (2013).
2. Conductor Shield: The conductor shield shall consist of an extruded semi-conducting thermosetting compound with thermal characteristics equal to or better than those of the insulation applied over the conductor. The conductor shield shall be of the material compatible chemically with both the conductor metal and the insulation, and shall be uniformly and firmly bonded to the inner surface of the insulation, and shall strip freely and cleanly from the conductor. The material and wall thickness of the extruded conductor shield shall be in accordance with AEIC CS6, Paragraph D-l.
3. Insulation: The primary insulation for the cable to be furnished under this specification shall be ethylene-propylene-rubber (EPR), meeting the dimensional, electrical and physical requirements specified in AEIC CS6 and NEMA WC 74 (2012). The average thickness of the insulation shall not be less than given in Table Cl of AEIC CS5 or AEIC CS6 for 133 percent insulation level. The insulation shall be applied in one continuous extrusion directly over the conductor shield and shall be a high quality, ozone and discharge resistant compound.
4. Insulation Shield: An insulation shield shall be extruded directly over the insulation. The shielding material shall be composed of a semi-conducting thermo setting compound and shall be compatible with the insulation. The insulation shield shall comply with the stripping test for extruded insulation shielding in accordance with Section D.3.1 and Section H of AEIC CS6. The average wall thickness of the extruded insulation shield shall not be less than given in Table D1, Section D of AEIC CS5 or AEIC CS6. The dc volume resistivity of the extruded insulation shield shall not exceed 50,000 ohm-centimeters.
5. Concentric Neutral Shield: The concentric neutral conductor consisting of uncoated copper wire shall be applied evenly over the semi -conducting nonmetallic covering with a lay of not less than six and not more than eight times

the diameter over the concentric neutral conductor. Provide 33% ampacity for three phase circuits, 100% ampacity for single phase circuits.

6. Jacket: An outer jacket shall be applied directly over the concentric neutral conductors. The jacket shall completely encapsulate the neutral conductors leaving no voids. The jacket shall consist of a water resistant LLDPE (Linear Low Density Polyethylene) compound. The minimum average thickness of the jacket over metallic neutral wires or straps shall be 50 mils, and the minimum thickness at any point shall not be less than 40 mils.
7. Packaging, Sealing and Shipping: The cable shall be placed on sturdy reels, sealed and shipped. Each end of each length on cable shall be hermetically sealed with a heat shrinkable electrometric cap fitting or other suitable means to protect against the entrance of moisture into the cable. Continuous lengths of cable shall be placed on individual reels. Reels shall be of substantial construction to withstand multiple handling during transit and storage. The cable shall be protected by the installation of heavy lagging on the reel. Each side of each reel shall be marked as follows: "Stand reel on rim only. DO NOT lay on side."
8. Grounding Cables: Grounding cables shall be copper, #1/0 AWG unless otherwise indicated on plans conforming to ASTM B 8 (2011) soft -drawn unless otherwise indicated; aluminum is not acceptable.

2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS

A. Medium-Voltage Cable Joint: Medium-voltage cable joints shall comply with IEEE 404 (2012) and IEEE 592 (2007). Medium-voltage cable terminations shall comply with IEEE 48 (2009). Joints shall be the standard products of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Joints shall have ratings not less than the ratings of the cables on which they are installed. All joints used in manholes, handholds, vaults and pull boxes shall be certified by the manufacturer for waterproof, submersible applications.

2.6 MEDIUM -VOLTAGE SEPARABLE INSULATED CONNECTORS

A. Separable insulated connectors shall comply with IEEE 386 (2011) and IEEE 592 (2007) and shall be of suitable construction or standard splice kits shall be used. Splice kits may be of the heat-shrinkable type for voltages up to 15 kV, of the Pre-molded splice and connector type, the conventional taped type, or the resin pressure - filled overcast taped type for voltages up to 35 kV; except that for voltages of 7.5 kV or less a resin pressure -filled type utilizing a plastic-tape mold is acceptable. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the load-break type for 200 amp connections and nonload-break for 600 amp connection, of suitable construction for the application and the type of cable connected, and include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points shall be provided.

B. Low-Voltage Cable Splices: Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A (2013). Splices in conductors Number 8 AWG and larger

shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A (2013). Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting re sin into a mold that surrounds the joined conductors.

C. Terminations: Terminations shall be in accordance with IEEE 48 (2009) - Class 1 or Class 2 of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene dienemonomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

1. Factory Preformed Type: Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build -up. Terminations shall have basic impulse levels as required for the system voltage level.
2. Taped Terminations: Taped terminations may be used for low voltage circuits only. Terminations shall use standard termination kits or approved tape and shall provide terminal connectors, and rain hoods as required. Terminations shall be at least 20 inches long from the end of the cable jacket to the start of the terminal connector or not less than the kit manufacturer's recommendations, whichever is greater.

2.7 CONCRETE

A. Reinforcement detailing and placement shall conform to CRSI's "Manual of Standard Practice." Concrete shall conform to ASTM C 94 (2014). Compressive strength in 28 days shall be 4,000 psi. Total air content of exterior concrete shall be between 4 and 7 percent by volume. Slump shall be between 2 and 5 inches. Concrete shall be cured for 7 days after placement.

B. Concrete used for ductbanks shall have sufficient red dye to impart a distinctive, readily apparent color.

2.8 CONDUIT AND DUCTS

A. Metallic Conduit: Intermediate metal conduit shall comply with UL 1242 (2014). Rigid galvanized steel conduit shall comply with UL 6 (2007) and ANSI C80.1 (2005). Metallic conduit fittings and outlets shall comply with UL 514A (2013) and NEMA FB 1 (2012).

B. Conduit Outlets and Fittings: NEMA FB 1 (2012), and UL 514A (2013).

C. Non-metallic ducts

1. Concrete Encased Ducts: Plastic duct NEMA TC 6 (2013) Type EB.
2. Direct Burial: Plastic UL 651 (2011) Schedule 40, or NEMA TC 6 Type DB.
3. Conduit Sealing Compound: Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2.9 GROUNDING AND BONDING

A. Equipment, UL 467 (2013). Wire, ASTM B 8 (2008), soft drawn copper. All connections below grade shall be fusion welded. Connections above grade shall be fusion welded or be made with connectors which comply with UL 467.

B. Driven Ground Rods: Ground rods shall be copper-clad steel conforming to UL 467 (467) not less than 3/4 inches in diameter by 10 feet in length.

2.10 CAST IRON

A. ASTM A 48 (2012), CLASS 30B.

2.11 PADLOCKS

A. Padlocks shall conform to FS FF-P-101. The type and keying requirements shall be coordinated through the Contracting Officer to match existing base standards.

2.12 SURGE ARRESTERS

A. NEMA LA 1 (2009) of the zinc-oxide type.

2.13 POLES AND HARDWARE

A. Poles and hardware shall be in accordance with Section 26 05 46 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Steel conduits installed underground shall be installed and protected from corrosion with factory installed coatings or half-lapped tape. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 31 20 00 EARTH MOVING Section 33 05 13 UNDERGROUND DUCTS AND UTILITY STRUCTURES. Concrete work shall conform to the requirements of this Section and

Section 03 30 00. All conduits, spare and used, shall be provided with pull strings for future use.

3.2 CABLES, GENERAL REQUIREMENTS

A. The type of installation, size and number of cables shall be as indicated. Conductors larger than Number 8 AWG shall be stranded. Each circuit shall be identified by means of fiber, laminated plastic, or nonferrous-metal tags, or approved equal, in each manhole, each handhole, each junction box, and at each terminal. Loads shall be divided as evenly as practicable on the various phases of the system. Manufacturer's written recommendations shall be furnished for each type of splice and medium-voltage cable joint and termination, and for fireproofing application methods, and shall be approved before any work is done. Medium-voltage cable joints and terminations shall be the standard product of a manufacturer and shall be either of the factory preformed type or of the kit type containing tapes and other required parts. Medium-voltage cable joints shall be made by qualified cable splicers. Compounds and tapes shall be electrical grade suitable for the cable insulation provided and shall use design materials and techniques recommended by the manufacturer. Maximum length of cable pull and cable pulling tensions shall not exceed the cable manufacturer's recommendations.

B. Duct Line Installation: All Cables shall be installed in duct lines.

3.3 MEDIUM -VOLTAGE CABLES

A. Medium-voltage cables shall be suitable for a rated circuit voltage of 15 kV. Other parts of the cable system such as joints and terminations shall have ratings not less than the rating of the cables on which they are installed. Separable insulated connectors shall have nominal voltage ratings coordinated to associated apparatus ratings rather than cable ratings when used to connect cable to apparatus. Cables shall be provided with 133 percent insulation level.

B. Cable Joints and Splices: All Joints and splices in medium voltage cables shall be of the fully shielded fully submersible separable insulated connector type, Elastimold 150T or 151S (200A) or 655L (600A) series or approved equal. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint. Cable joints shall provide insulation and jacket equivalent to that of the associated cable.

C. Terminations: Terminations shall be IEEE 48 (2009), Class 1 or Class 2; of the molded elastomer, wet- process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene dienemonomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable. Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the-cable

shielding, metallic sheath, and armor.

1. Factory Preformed Type: Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build -up. Terminations shall have basic impulse levels as required for the system voltage level. Leakage distances shall pass the wet withstand voltage test required by IEEE 48 (2009) for the next higher BIL level.

3.4 DUCT LINES

A. Duct lines for shall be concrete-encased, thin -wall type for medium-voltage lines. Low-voltage lines run elsewhere may be non-encased direct-burial, thick-wall type conforming to ASTM D 2447 (2003) for schedule 40. All ducts under traveled roadways, parking areas, and any other area subject to vehicular traffic shall be concrete encased.

B. Requirements: Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3-inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends as required, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes. A 5-mil brightly colored plastic tape not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1-mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

C. Treatment: Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. After a duct line is completed, a standard flexible mandrel shall be used for cleaning followed by a brush with stiff bristles. Mandrels shall be at least 12 inches long and have diameters 1/4 inch less than the inside diameter of the duct being cleaned. Pneumatic rodding may be used to draw in lead wires. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

D. Concrete Encasement: Where shown or specified, each single duct shall be completely encased in concrete with a minimum of 3 inches of concrete around each duct, except that only 2 inches of concrete are required between adjacent electric power or adjacent communication ducts, and 4 inches of concrete shall be provided between adjacent electric power and communication ducts. Duct line encasements shall be monolithic

construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. At any point, except railroad crossings, tops of concrete encasements shall be not less than 18 inches below finished grade or paving. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not further apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.

E. Nonencased Direct-Burial: Top of duct lines shall be below frost line but not less than 24 inches below finished grade. Ducts shall be buried below frost line but in the earth and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Where bottoms of trenches comprise materials other than sand or stone- free earth, 3 -inch layers of sand or stone-free earth shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts in direct-contact tiered fashion. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 4-inch layer of backfill cover shall be sand or stone-free earth compacted as previously specified. Duct banks may be held in alignment with earth. However, high-tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling. Selected earth at duct banks shall be thoroughly tamped in 4 - to 6-inch layers.

F. Installation of Couplings: Joints in each duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved. In the absence of specific recommendations, various types of duct joint couplings shall be made watertight as specified.

1. Plastic Duct: Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick one-quarter-turn twist to set the joint tightly.

3.5 PRIMARY SECTIONALIZING ENCLOSURES

A. All enclosures shall be 3-phase, four-point, non-fused, rated for 600 amp continuous at 15 kV. Enclosure shall be fiberglass as detailed on the plans with hinged doors for access to the sectionalizing terminals. Junctions shall be made using separable connectors conforming to ANSI 386 requirements. Enclosures shall be similar in design and construction to the enclosures used for vacuum switch enclosures.

3.6 CONCRETE PADS, GENERAL

A. Concrete pads shall be constructed as required for each piece of equipment and sized to provide 12 inches of surface beyond equipment side walls in all directions. Tops of concrete pads shall be level and shall project 4 inches above finished paving or grade and sloped to drain. Conduits for primary, secondary, and grounding conductors shall be set in place prior to pouring of concrete pads.

3.7 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

A. Connections between aerial and underground systems shall be made as shown.

Underground cables shall be extended up poles in conduit to cable terminations. Conduits shall be secured to the poles or structures by 2-hole galvanized steel pipe straps spaced not more than 10 feet apart and with one strap not more than 12 inches from any bend or termination. Conduits shall be equipped with bushings to protect cables and minimize water entry. Cables shall be supported by devices separate from the conduit, near their point of exit from the conduit.

3.8 LOW -VOLTAGE CABLES

A. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 Volts. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A (2013). Splices in wires Number 8 AWG and larger shall be made with non-insulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B (2013). They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. All splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 (2011) or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

3.9 GROUNDING

A. Neutral conductors, cable shields, metallic cable sheaths and armor, metallic conduits, cable terminations, junction boxes, poles, surge arresters, fencing enclosing electrical equipment, and other noncurrent- carrying metallic parts of equipment shall be grounded.

B. General Requirements: A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured in normally dry conditions not less than 48 hours after rainfall. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

1. Ground Rods: Ground rods shall be copper-clad steel conforming to UL 467 not less than ¾ inches in diameter by 10 feet in length. Unless otherwise indicated, ground rods shall be driven into the ground until tops of rods are approximately 1 foot below finished grade. In counterpoise systems tops of ground rods, shall be approximately at elevations of counterpoises. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional grounds rods, longer ground rods , or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional a-foot ground rods shall be required at anyone installation. Ground rods shall be spaced as evenly as possible at least 6 feet apart and connected 2 feet below grade.
2. Connections: Connections below grade shall be made by a fusion-welding process. Where ground wires are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for

this purpose shall be utilized.

C. Equipment Grounding: Equipment frames of metal-enclosed equipment, medium-voltage cable shields at cable joints and terminations, metal splice boxes, chain -link fencing, and other noncurrent-carrying metal items, shall be grounded unless otherwise indicated. Connections to earth shall be made in the same manner as required for neutral grounding. Equipment or devices operating at less than 750 volts may be connected to secondary neutral grounds. Equipment opera ting at more than 750 volts to ground shall be provided with grounds separate from secondary neutral grounds, but both grounds shall be bonded together below grade at the ground rods or may utilize a common counterpoise.

D. Surge Arrester Grounding: Surge arresters shall be grounded using copper conductors. Resistance to ground for intermediate-class arresters shall be not more than 10 ohms and for distribution-class, arresters shall be not more than 25 ohms. Ground wire connections shall be not less than Number 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters. Connections to earth shall be made in the same manner as required for neutral conductors. Surge arrester grounds may use the same ground wires provided for equipment operating at more than 750 volts. Surge arrester and secondary neutral grounds shall be separate from and independent of each other but both grounds shall be bonded together below grade at the ground rods or may utilize a common counterpoise.

3.10 CONNECTIONS BETWEEN OVERHEAD BUS AND UNDERGROUND SYSTEMS

A. Connections substation bus and underground systems shall be made as shown on the plans.

3.11 GROUNDING CONNECTIONS

A. The new ground rods and counterpoise shall be bonded together and to the existing ground mat in the existing substation.

B. Tests

1. Operating Test: After the installation is completed, the Contractor shall conduct an operating test for approval in accordance with Section 01070, “Contractor Quality Assurance/Quality Control.” Equipment shall be demonstrated to operate in accordance with the requirements herein. Tests shall be performed in the presence of the Contracting Officer. The Contractor shall furnish instruments and personnel required for the test and the Government will furnish the necessary electric power.
2. Ground-Resistance Measurements: Ground-resistance measurements of each ground rod shall be taken and certified by the Contractor to the Contracting Officer. No part of the electrical distribution system shall be energized prior to the resistance testing of that system's ground rods and grounding system and submission of test results to the Contracting Officer. Test reports shall indicate the location of the ground rod and grounding system, and the resistance and the soil conditions at the time the test was performed. When the building water service is used as a ground or part of the grounding system, ground-resistance measurements shall also be made of this dry weather, not less than 48 hours

after rainfall, and with the ground under test isolated from other grounds. The resistance to ground shall be measured using the fall-of-potential method described in IEEE 142 (2007).

3. Medium-Voltage Cable Test: After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct- current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shields or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time, and other characteristics of the test shall be in accordance with NEMA WC 74 (2012), and shall not exceed the recommendations of IEEE 404 (2012) for cable joints and IEEE 48 (2009) for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed.

3.12 QUALITY CONTROL

A. The Contractor shall establish and maintain quality control for operations under this section to assure compliance with contract requirements and maintain records of his quality control for materials, equipment, and construction operations. See Section entitled "CONTRACTOR QUALITY ASSURANCE/QUALITY CONTROL".

END OF SECTION 25 05 43

SECTION 26 05 46 – ELECTRICAL DISTRIBUTION SYSTEM, AERIAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL REQUIREMENTS

A. Terminology: Terminology used in this specification is as defined in IEEE 100 CD (2009).

B. Service Conditions: Items provided under this section shall be specifically suitable for the following service conditions.

1. Seismic Category C, Importance Factor 1.

1.3 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 “Submittal Procedures” in sufficient detail to show full compliance with the Contract Documents:

B. Data

1. Protective Device Study: A Short Circuit and Protective Device Coordination Study shall be prepared and submitted for all protective devices included in this section in accordance with Paragraph 1.2.G of SECTION 26 11 13, MAIN ELECTRIC SUPPLY STATION.
2. Manufacturer's Catalog: Submit data composed of catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.
3. Material, Equipment, and Fixture Lists: A complete itemized listing of equipment and materials proposed for incorporation into the work shall be submitted. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

C. Drawings

1. Electrical Distribution System: Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings. Detail drawings shall as a minimum include:

a. Poles
b. Calculations for concrete poles and power installed screw foundations.
c. Cross-arms

d. Pole top switches.
e. Conductors
f. Insulators
g. Surge arresters.
h. Transformers

2. If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

3. Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

   a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication,
   b. Provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight.
   c. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

D. Reports

1. Factory Test: Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications.

2. Field Testing: A proposed field test plan 30 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

3. Test Reports: Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

   a. A list of all equipment used, with calibration certifications.
   b. A copy of all measurements taken.
   c. The dates of testing.
   d. The equipment and values to be verified.

e. The condition specified for the test.
f. The test results, signed and dated.
g. A description of all adjustments made.

E. Certificates

1. Materials and Equipment: Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided under this section of the specifications conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform thereto. A sealed or notarized certification by a professional engineer or a company officer of the responsible manufacturer to the effect that the item is in accordance with the referenced ANSI or IEEE standard, 'will be acceptable as evidence that the item conforms thereto. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms thereto. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

F. Operation and Maintenance Manuals

1. Electrical Distribution System: Provide operation and maintenance manuals for the electrical distribution system in compliance with Section 01782, “Operation and Maintenance Data.”

1.4 DELIVERY, STORAGE, AND HANDLING

A. Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Transformers and switches shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than two weeks shall be stored in accordance with ASC/05 05.1 (2008). Concrete poles shall be handled and stored in accordance with the manufacturer's instructions.

1.5 EXTRA MATERIALS

A. One additional spare fuse or fuse element for each furnished fuse or fuse element by type and size shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable toolbox. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate,

adjust, or maintain special parts).

PART 2 - PRODUCTS

2.1 STANDARD PRODUCT

A. Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

2.2 NAMEPLATES

A. General: Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Equipment containing liquid -dielectrics shall have the type of dielectric on the nameplate. Nameplates shall be made of noncorrosive metal. As a minimum, nameplates shall be provided for transformers, regulators, circuit breakers, capacitors, meters and switches.

B. Liquid -Filled Transformer Nameplates: Nameplates shall indicate percent impedance, voltage, kVA, frequency, number of phases, cooling class, insulation class, temperature rise, the number of gallons and composition of transformer liquid dielectric, and shall be permanently marked with a statement that the transformer dielectric is non- polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 1 ppm PCB content in accordance with paragraph MISCELLANEOUS. Liquid Dielectrics Certifications shall be related to serial numbers on transformer nameplates. Transformers with dielectric PCB content exceeding 1 ppm or transformers without certification will be considered as PCB insulated and will not be accepted.

2.3 CORROSION PROTECTION

A. Aluminum Materials: Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B (2013) shall be used.

B. Ferrous Metal Materials

1. Hardware: Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 (2009) and ASTM A 123 (2009).
2. Equipment: Equipment and component items, including but not limited to transformers and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 480 hours of exposure to the salt spray test specified in ASTM B 117 (2011) without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The described test mark and test evaluation shall be in accordance with ASTM D 1654 (2008) with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill

galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.4 CONDUCTORS, CONNECTORS, AND SPLICES

A. Aluminum-Composition Conductors: All-aluminum-conductors, AAC, shall be alloy 1350 -H19 and comply with ASTM B 230 (2012) and ASTM B 231 (2013). All-aluminum-alloy-conductors, AAAC, shall be alloy 6201-T81 and comply with ASTM B 398 (2014) and ASTM B 399 (2010). Aluminum-conductor-steel-reinforced, ACSR, shall comply with ASTM B 232 (2011).

B. Copper Conductors: Hard -drawn -copper conductors shall comply with ASTM Bland ASTM B 8 (2011) as appropriate for the conductor size.

C. Connectors and Splices: Connectors and splices shall be of copper alloys for copper conductors, aluminum alloys for aluminum-composition conductors, and a type designed to minimize galvanic corrosion for copper to aluminum-composition conductors. Aluminum-composition and aluminum- composition to copper shall comply with UL 486B (2013), and copper to copper shall comply with UL 486A (2013).

2.5 MEDIUM-VOLTAGE LINES

A. Bare Medium-Voltage Lines: Bare medium-voltage line conductors shall be #397.5, 26/7 strand aluminum-conductor-steel-reinforced, ACSR unless otherwise shown. Existing Conductor may be re - used where indicated, however, conductor types shall not be mixed on any span or line section unless specifically indicated. Conductors larger than Number 2 AWG shall be stranded.

2.6 LOW-VOLTAGE LINES

A. Low-voltage line conductors shall be of the neutral-supported secondary and service drop type with cross -linked thermosetting polyethylene (XLP) insulation in accordance with NEMA WC 70 2009). Neutral- supported secondary and service drop conductors shall be insulated aluminum with bare 1350 alloy aluminum or ACSR neutrals. Conductors on secondary racks may be provided in lieu of neutral- supported cable for pole line circuits where necessary clearances are available when reconnecting to existing circuits of that type construction.

2.7 POLES AND HARDWARE

A. Installation shall comply with the requirements of ANSI C2 (2012) for Grade B construction for a NESC medium loading district. Joint-use electric/roadway-lighting poles for overhead electric and communication lines shall be concrete (or wood for temporary use) utilizing armless construction drilled using drilling pattern for a particular type pole per standards provided by Contracting Officer. Cluster- mounted, banked single -phase transformer installations shall be provided. Crossarm construction shall be provided for support of other equipment, except where direct-pole mounting is approved or indicated. Pole equipment mounts attached with stainless steel bands may be used for concrete poles where specifically approved in the equipment submittal request. Detail drawings shall be submitted for approval. Provision for communication services is required on pole -line construction, except where

specifically noted otherwise. A vertical pole space of not less than 2 feet shall be reserved at all locations. Poles shall be furnished in equivalent wood pole classes defined as ground line moments equal to or greater than that of a wood pole of the same class shown with no regard to overload factors. For purposes of this project, the following minimum ratings shall apply to classes shown on the drawings:

Class	Length (Feet)	Tip-Butt Diameter (Inches)	G.L. Moment (ft-K)
4	40	7.75/14.95	90
	45	7.75/15.85	103
	50	7.83/18.63	114
	55	7.83/19.71	123
2	40	8.91/17.55	129
	45	8.91/18.63	164
	50	8.91/19.71	181
	55	8.91/20.79	197
H2	70	8.91/24.02	245
	75	8.91/25.11	260
	80	8.91/26.17	274
	85	8.91/27.27	290

B. Strengths for lengths not shown shall be proportionally more or less for the class required based on ground line moment values shown above. The contractor shall insure that class 2 poles (H2 for 60' & above) as defined above be used in all cases as follows:

1. Equipment mountings weighing more than 250 lbs.
2. Un-guyed angles.
3. Deadend construction or guyed angles using deadend construction for one or more directions.

C. Concrete Poles: Concrete poles shall be designed to withstand the loads specified in ANSI C2 (2012) multiplied by the appropriate overload capacity factors for NESC Class C construction with conductor sizes and stringing tensions specified. Poles shall be spun pre-stressed type. Poles shall be manufactured by a centrifugal spinning process with concrete pumped into a polished round tapered metal mold. Concrete for spun poles shall have a compressive strength of at least 5000 psi at 28 days; steel wire shall have an ultimate tensile strength of at least 120,000 psi; and reinforcing bars shall have an ultimate tensile strength of at least 40,000 psi. After the high speed spinning action is completed, a spun pole shall be cured by a suitable wet steam process. Spun poles shall not absorb more than three percent water to eliminate cracking and to prevent erosion. Concrete poles shall have hollow shafts. Poles shall have a hard, smooth, nonporous surface that is resistant to soil acids, road salts, and attacks of water and frost. Poles shall not be installed for at least 15 days after manufacture. Fittings and brackets that conform to the concrete pole design shall be provided using standard drilling patterns for the base as provided by the contracting officer modified as required for pole construction details shown. Poles shall conform to strength calculations performed by a registered professional engineer and submitted in accordance with detail drawings portion of paragraph SUBMITTALS.

D. Pole Line Hardware: Zinc-coated hardware shall comply with IEEE C135.1 (1999), IEEE C135.2 (1999) and IEEE C135.22 (1988). Steel hardware shall comply with ASTM A 575 (2013) and ASTM A 576 (2012). All hardware shall be hot-dip galvanized in accordance with ASTM A 153 (2009). Pole-line hardware shall be hot-dip galvanized steel, except anchor rods of the copper-molten welded-to-steel type with nonferrous corrosion-resistant fittings shall be used. Suitable washers shall be installed under bolt heads and nuts. Washers used on through -bolts and double -arming bolts shall be approximately 2-1/4 inches square and 3/16-inch thick. The diameter of holes in washers shall be the correct standard size for the bolt on which a washer is used. Washers for use under heads of carriage- bolts shall be of the proper size to fit over square shanks of bolts. Eye bolts, bolt eyes, eye nuts, strain -load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to support and to protect poles, brackets, crossarms, guy wires, and insulators. Banding for attachment of equipment to concrete poles shall be stainless steel with stain less hardware.

E. Armless Construction (15 kV System Voltage): Pole mounting brackets for line-post or pin insulators shall be fiberglass type with hardware as recommended by the insulator manufacturer for class construction and line tension specified and pole type shown. Pole top brackets and side arm or double arm brackets shall be sized, selected and mounted on the pole so as to provide a 30 inch minimum clearance between phase conductors in any direction and a 12 inch clearance to any grounded surface or part (the insulator may be included in the clearance distance). Brackets shall provide the following minimum ultimate strengths at point of support of the conductor: Transverse - 1900 lbs.; Longitudinal - 1900 lbs.; Vertical - 2250 lbs. Brackets shall be attached to poles with a minimum of two bolts. Brackets may be either provided integrally as part of an insulator or attached to an insulator with a suitable stud. Bracket mounting surface shall be suitable for the shape of the pole. Brackets for wood poles shall have wood gripping members. Horizontal offset brackets shall have a 5-degree uplift angle. Pole top brackets shall conform to IEEE C135.22 (1988), except for modifications necessary to provide support for a line-post insulator if so shown. Deadend brackets shall be 60" (minimum) hot-dip galvanized steel with a minimum rating of 5000 lbs. per conductor tensions at design attachment points. Brackets shall provide a strength exceeding that of the required insulator strength, but in no case have less than a 2000 pound cantilever strength.

F. Armless Construction (46 KV System Voltage): Post insulators with horizontal clamp type tops and gain type base brackets for vertical line construction shall be used for 46 KV structures. The insulators provided shall be Newell porcelain Co. Catalog No. 43740 or approved equal.

G. Guy Assemblies: Guy assemblies shall be aluminum-clad steel in accordance with ASTM B 416 (2013) copper-clad steel in accordance with ASTM B 228 (2011) or zinc-coated steel in accordance with ASTM A 475 (2014). Guy assemblies, including insulators and attachments, shall provide a strength exceeding the required wire breaking strength for the guy load to be supported. Three-eye thimbles shall be provided on all anchor rods to permit attachment of individual primary, secondary, and communication down guys. Rods shall be 1" high-strength steel for lines with conductor sizes of 397 Kcmil or larger. Anchors shall provide adequate strength to support all loads attached and shall be selected for Class 6 soil types except as shown or approved otherwise. Seven strand guys shall be used. Guy material shall be as a

minimum class A zinc-coated-steel high-strength or extra -high-strength grade, with a ' minimum breaking strength not less than 10,000 pounds for high strength or 15,400 pounds for extra high strength. The minimum load rating of the guy assembly at point of attachment to structure shall be as follows (increase by 10% for deadends):

Conductor (ACSR)	Loading	Required Guy Assembly Rating per Wire at 45° Lead Angle
#6 through #1/0	2,000 lbs. per conductor	2,8750 lbs.
#2/0 through 397 Kcmil	5,000 lbs. per conductor	7,100 lbs.
397 through 795 Kcmil	10,000 lbs. per conductor	14,200 lbs.

H. The above ratings are based on initial 70° F stringing tensions not to exceed 1000 lbs./conductor for #1/0; 3,500 lbs./conductor for 397 Kcmil; and 6,400 lbs./conductor for 795 Kcmil. Rating shall be increased for shield wire tensions as required by size and initial stringing tension of the wire. The Neutral shall be counted as a phase conductor in selecting guy assembly rating. Secondary or communications conductors shall be considered in guy sizing for new poles or replacement poles where such services exist to the extent required to match the existing installation strengths. The contractor may re-use existing anchors for such services if provided separate from power system guy and in good condition and so approved. Provide new guying for all new secondary installations as required for stringing tensions used. Different lead angles, turn angles and conductor quantity will require additional strength and contractor shall modify the guy assembly or use one assembly per conductor as required to achieve necessary rating.

I. Where two or more guys are used to provide the required strength, the load shall be proportionally distributed. The load rating of the guy assembly shall be determined by multiplying the guy assembly minimum breaking strength by the sine of the lead angle of the guy to be installed. Guy rods shall be not less than 8 feet in length by 5/8-inch in diameter.

J. The contractor shall perform a calculation or use the anchor manufacturer's recommended sizing procedures for each structure to be guyed to verify that guy assembly strength is adequate for the application, taking into account actual site conditions including soil type, lead angle, turn angle and stringing tensions being used. Should guy strength be questionable, the contractor shall immediately notify the contracting officer of the problem.

2.8 INSULATORS

A. Insulators shall comply with NEMA HV 2 (2014) for general requirements. Suspension insulators shall be used at corners, angles, dead-ends, other areas where line insulators do not provide adequate strength, and as indicated. Mechanical strength of suspension insulators and hardware shall exceed the rated breaking strength of the attached conductors.

B. Medium-Voltage Line Insulators: Medium-voltage line insulators shall comply with

NEMA C29.2 (2012), NEMA C29.5 (2012), NEMA C29.6 (2012), and NEMA C29.7 (2012) as applicable. Ratings shall not be lower than the NEMA classes indicated in TABLE I. Horizontal line -post insulators shall be used for armless construction at voltages above 15 KV and shall have the same mechanical and electrical ratings as vertical line-post insulators for the NEMA class indicated, but shall be modified to be suitable for horizontal installation. Where line-post insulators are used for angles greater than 15 degrees, clamp -top fittings shall be provided as well as for other locations shown. Conductor clamps for use with clamp -top, line-post insulators shall be hot-dip galvanized malleable iron for copper conductors and aluminum alloy for aluminum-composition conductors. Either line -post or pin insulators may be used for crossarm construction. Pin insulators for use on voltages in excess of 5 kV phase-to-phase shall be radio -interference-freed or else line-post insulators shall be used.

TABLE I. MINIMUM NEMA RATING OF MEDIUM-VOLTAGE INSULATORS BY CLASS

Voltage Level (kV)	Line-Post	Pin	Suspension
15.0	57-or-11	55-4	Two 52-3 or Three 52-9
46.0	57-3 29” leakage 125 KV dry flashover 2,800 lbs. cantilever strength 5,000 lbs. tension strength		Five 52-3 or 4

C. Low Voltage Line Insulators: Low-voltage line insulators shall comply with NEMA C29.2 (2012) and NEMA C29.3 (2012) as applicable. Spool insulators for use on low-voltage lines shall be mounted on clevis attachments or secondary racks and shall be not smaller than Class 53-2. For No. 4/0 AWG and larger conductors, Class 53-4 shall be used. Suspension insulators on clevis attachments used at dead -ends shall be not smaller than Class 52-1.

D. Strain Insulators for Guy Wires: Strain insulators for use in insulated guy assemblies shall comply with NEMA C29.4 (2012) for porcelain or equivalent fiberglass, and shall have a mechanical strength exceeding the rated breaking strength of the attached guy wire. Insulators shall be not smaller than Class 54-2 for lines of 6 kV to 15 kV.

E. Apparatus Insulators: Apparatus insulators shall comply with IEEE C57.19.00 (2004), IEEE C57.19.01 (2005), NEMA C29.8 (2012), and NEMA C29.9 (2012) as applicable.

2.9 CROSSARM ASSEMBLIES

A. Crossarms: Crossarms shall comply with REA DT-5B and be 54" fiberglass type rated for 9,000 lbs. ultimate load or hot dip galvanized steel where shown. The fiberglass type shall be heavy duty, ultraviolet light resistant with a 3" solid fiberglass rod similar to Continental type GDEAX-58-3.0-54 or approved equal. Wood type where indicated

for temporary use shall be solid wood, distribution type, except cross -sectional area with pressure treatment conforming to AWPA C25, and a 1/4- inch, 45 degree chamfer on all top edges. Cross-sectional area minimum dimensions shall be 4-1/4 inches in height by 3-1/4 inches in depth in accordance with ANSI C2 (2012) for Grade B construction. Steel Crossarms shall be 5 feet in length, except that a-foot crossarms shall be used for crossarm-mounted banked single -phase transformers or elsewhere as indicated. Crossarms shall be machined, chamfered, trimmed, and bored for stud and bolt holes before pressure treatment. Factory drilling shall be provided for pole and brace mounting, for four pin or four vertical line-post insulators, and for four suspension insulators, except where otherwise indicated or required. Drilling shall provide required climbing space and wire clearances. Crossarms shall be straight and free of twists to within 1/10-inch per foot of length. Bend or twist shall be in one direction only.

2.10 FUSES AND SWITCHES, MEDIUM-VOLTAGE

A. Medium-voltage fuses and cutouts shall comply with IEEE C37.42 (2012) and shall be of the non-load break open type construction rated 15 KV, 200A and of the ultra -heavy-duty type (10,000 A interrupting rating) fused as indicated. Open-link cutouts are not acceptable. Fuses shall be either indicating or dropout type. Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

B. Non-Fused Disconnect Switches: Non-fused switches shall be single -pole, manual devices with a continuous current rating 600 amperes rms or as shown, a momentary asymmetrical current rating of 40 kA rms, and shall be rated for the voltage of the system in which it is installed.

C. Group-Operated Load Interrupter Switches: Group-operated load interrupter switches shall be rated 600 amperes (minimum except as shown otherwise), comply with IEEE C37.32 (2002) for voltage class required and shall be of the outdoor, manually -operated, three-pole, single -throw type with either tilting or rotating insulators and equipped with interrupters capable of interrupting currents equal to a switch's continuous current rating. Each switch shall be suitably preassembled for the indicated configuration and mounting. Moving contacts shall be of the high-pressure, limited area type, designed to ensure continuous satisfactory contact. Switches shall be fused or non-fused as indicated. Switches shall be complete with necessary operating mechanisms, handles and other items required for manual operation from the ground. Switch operating handles shall be located approximately three feet six inches above grounded platform plates. Each handle shall be provided with a padlock arranged to lock the switch in both the open and the closed position. The Contractor shall provide Padlocks for each switch keyed to match existing padlocks using pattern furnished by the Contracting Officer.

2.11 SURGE ARRESTERS

A. Surge arresters shall be Heavy-duty non-fragmenting type and shall comply with IEEE C62.2 (1994) and IEEE C62.11 (2012). Arrestors shall be provided for protection of all aerial-to-underground transitions, potential transformers, capacitor equipment, group-operated load-interrupter switches, transformers and other equipment whether specifically shown on drawings or not. Arresters for equipment protection shall be distribution class, rated for system -voltage shown. Arrestors for cable protection at underground to aerial transitions shall be intermediate class or extra heavy duty

distribution class designed for use on underground risers. The maximum discharge voltage of underground riser type arrestors shall not exceed 32 KV for 40 KA discharge currents per manufacturer's published ratings at an MCOV of 7.65 KV for a 12.47 KV system voltage. Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the gap -less metal-oxide varistor type suitable for outdoor installations.

2.12 GROUNDING AND BONDING

A. Driven Ground Rods: Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10-feet in length of the sectional type.

B. Grounding Conductors: Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as the phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 (2011) soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2.13 PADLOCKS

A. Padlocks shall comply with ASTM F 883 (2013) keyed to match base standard as directed.

2.14 WARNING SIGNS

A. Warning signs shall be porcelain enameled steel or approved equal. Voltage warning signs shall comply with ANSI C2 (2012).

2.15 LIQUID DIELECTRICS

A. Liquid dielectrics for transformers, capacitors, reclosers, and other liquid -filled electrical equipment shall be mineral oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 tetrachlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than 1 parts -per-million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 (2007) and have tests performed per ASTM D 4059 (2010) at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding 1 ppm shall be replaced.

2.16 FACTORY TESTS

A. Factory tests shall be performed as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified in accordance with Section 01070, “Contractor Quality Assurance/Quality Control.”

1. High-Voltage Air Switches: Manufacturer's standard tests in accordance with IEEE C37.34 (1994) and IEEE C37.41 (2008).
2. High-Voltage Fuses: Manufacturer's standard tests in accordance with IEEE

C37.41 (2008).

3. Electric Power Insulators: Manufacturer's standard tests in accordance with NEMA C29.1 (2012).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Circuits installed in conduits or underground and splices and terminations for medium- voltage cable shall conform to the requirements of Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Secondary circuits installed in conduit on poles shall conform to the requirements of Section 16415 ELECTRICAL WORK, INTERIOR except that above ground riser conduits shall be rigid hot-dip galvanized steel.

B. Conformance to Codes: The installation shall comply with the requirements and recommendations of NFPA 70 (2014) and ANSI C2 (2012) for medium loading districts, Grade C construction. No reduction in clearance shall be made.

C. Verification of Dimensions: The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall notify the Contracting Officer of any discrepancy before performing any work.

D. Tree Trimming: Where lines pass through trees, trees shall be trimmed at least 8 feet clear on both sides horizontally and below or as shown, for medium-volt age lines, and 4 feet clear on both sides horizontally and below for other lines, and no branch shall overhang horizontal clearances. Trees shall be removed as required to provide a clear right-of-way.

3.2 POLE INSTALLATION

A. Pole Setting: Poles shall be set straight and firm. Pole setting depths shall be 10% of length plus 2 feet or as shown. In rocky or swampy ground, pole -setting depths shall be decreased or increased as directed. In swampy or soft ground, holes shall be backfilled with gravel 6" beyond shaft radius and thoroughly compacted. Poles in straight runs shall be in a straight line. Curved poles shall be placed with curvatures in the direction of the pole line. Poles shall be set to maintain as even a grade as practicable. When the average g round run is level, consecutive poles shall not vary more than 5 feet in height. When the ground is uneven, poles differing in length shall be kept to a minimum by locating poles at points other than the highest and lowest ground points. Where conditions require reducing the length of a wood pole, the excess shall be removed from the pole top. The exposed end shall then treated with hot preservative and roofed. Where poles are set on hilly terrain, along edges of cuts or embankments, or where soil may be washed out, special precautions shall be taken to ensure durable pole foundations, and the setting depth shall be measured from the lower side of the terrain. Holes shall be dug large enough to permit proper use of tampers to the full depth of a hole. Earth shall be placed into a hole in 6-inch maximum layers, and then thoroughly tamped before the next layer is placed. Surplus earth shall be placed around a pole in a conical shape and packed tightly to drain water away from

poles. Concrete Poles may be mounted on cast-in-place or power-installed screw foundations. Otherwise, concrete poles shall be embedded in accordance with the details shown at a minimum depth specified above. Conduit elbows shall be provided for cable entrances into pole interiors if such space is used as a raceway.

1. Cast-In-Place Foundations: Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in Section 03300A CONCRETE FOR BUILDING CONSTRUCTION. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles s hall be set plumb. Anchor bolts shall be the manufacturer's standard, and not less than necessary to meet the pole wind loading specified herein and other design requirements.

2. Power-Installed Screw Foundations: Power-installed screw foundations having the required strength and mounting-bolt, top plate dimensions may be utilized. Screw foundations shall be of at least 1/4-inch thick structural steel conforming to ASTM A 36 (2012) and hot-dip galvanized in accordance with ASTM A 123 (2013). Conduit slots in screw foundation shafts and top plates shall be marked to indicate orientation. Design calculations indicating adequate strength shall be approved before installation of any screw foundation is permitted. Calculations shall be submitted in accordance with the detail drawings portion of paragraph SUBMITTALS.

3.3 CROSSARM MOUNTING

A. Crossarms shall be bolted to poles with 5/8-inch bolts with square washers at each end or as recommended by pole manufacturer for concrete poles. Bolts shall extend not less than 1/8 inch or more than 2 inches beyond nuts. On single crossarm construction, the bolt head shall be installed on the crossarm side of the pole. Metal or Wood crossarm braces shall be provided on wood crossarms. Flat braces may be provided for 8-foot crossarms and shall be ¼ inch by 1¼ inch, not less than 28 inches in length. Flat braces shall be bolted to arms with 3/8-inch carriage bolts with round or square washers between boltheads and crossarms, and secured to poles with 1/2-inch by 4 -inch lag screws after crossarms are leveled and aligned. Angle braces are required for 10-foot wood crossarms and shall be 60 -inch span by 18-inch drop formed in one piece from 1-1/2 inch by 1-1/2 inch by 3/16-inch angle. Angle braces shall be bolted to crossarms with 1/2-inch bolts with round or square washers between boltheads and crossarms, and secured to poles with 5/8-inch through-bolts. Double crossarms shall be securely held in position by means of 5/8-inch double -arming bolts or as recommended on concrete poles. Each double - arming bolt shall be equipped with four nuts and four square washers.

B. Line Arms and Buck Arms: Line arms and buck arms shall be set at right angles to lines for straight runs and for angles 45 degrees and greater; and line arms shall bisect angles of turns of less than 45 degrees. Dead-end assemblies shall be used for turn where shown. Buckarms shall be, installed, as shown, at corners and junction poles. Double crossarms shall be provided at ends of joint use or conflict sections at dead-ends, and at angles and corners to provide adequate vertical and longitudinal strength. Double crossarms shall be provided at each line-crossing structure and where lines not

attached to the same pole cross each other.

C. Equipment Arms: Equipment arms shall be set parallel or at right angles to lines as required to provide climbing space. Equipment arms shall be located below line construction to provide necessary wire and equipment clearances.

3.4 GUY INSTALLATION

A. Guys shall be provided there shown, with loads and strengths as specified, and wherever conductor tensions are not balanced, such as at angles, corners, and dead-ends. Where a single guy will not provide the required strength, two or more guys shall be provided. Where guys are wrapped around poles, at least two guy hooks shall be provided and pole shims shall be provided where guy tension exceeds 6,000 pounds. Guy clamps 6 inches in length with three 5/8-inch bolts, or offset-type guy clamps, or approved guy grips shall be provided at each guy terminal. Guy -strain insulators shall be provided in each guy where energized conductors are attached to the pole below the point of guy attachment. The strain insulator shall be placed below the level of any energized conductor and placed so that the lower portion of the insulator will not be less than 8 feet above grade if the guy was cut loose at its anchor. Multiple-helix screw anchors shall be provided in marshy ground; rock anchors shall be installed in rock at right angles to guys, elsewhere anchors shall be of an expanding type, except that power installed screw anchors of equivalent holding power are acceptable. A half-round yellow polyvinyl, fiberglass, or other suitable plastic guy marker, not less than eight feet in length, shall be provided at the anchor end of each guy, securely clamped to the guy or anchor at the bottom and top of the marker. Holding capacities for down guys shall be based on a lead angle of 45-degrees or otherwise as indicated or specified.

3.5 CONDUCTOR INSTALLATION

A. Line Conductors: Unless otherwise indicated, conductors shall be installed in accordance with manufacturer's approved tables of sags and tensions to provide a final no-wind resting tension of approximately 18% ultimate at 60° F. The actual stringing tension shall be selected so that final tension at 15° F, .25 lb./ft. ice load, 4.0 lb. wind load and with 0.05 lb./ft. NESC adder will not exceed 25% ultimate breaking strength for ruling span to be installed. Proper care shall be taken in handling and stringing conductors to avoid abrasions, sharp bends, cuts, kinks, or any possibility of damage to insulation or conductors. Conductors shall be paid out with the free end of conductors fixed and cable reels portable, except where terrain or obstructions make this method unfeasible. Bend radius for any insulated conductor shall be at no time less than the applicable NEMA specification recommendation. Conductors shall not be drawn over rough or rocky ground, or around sharp bends. When installed by machine power, conductors shall be drawn from a mounted reel through stringing sheaves in straight lines clear of obstructions. Initial sag and tension shall be checked by the Contractor, in accordance with the manufacturer's approved sag and tension charts, within an elapsed time after installation, recommended by the manufacturer.

B. Connectors and Splices: Connectors and splices shall be mechanically and electrically secure under tension and shall be of the nonbolted compression type. The tensile strength of any splice shall be not less than the rated breaking strength of the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and

shall not adversely affect conductors. Aluminum-composition conductors shall be wire brushed and an oxide inhibiter applied before making a compression connection. Connectors which are factory -filled with an inhibiter are acceptable. Inhibitors and compression tools shall be of types recommended by the connector manufacturer. All Primary line apparatus taps to both new construction and existing construction shall be by means of hot line clamps attached to compression type bail clamps (stirrups). Low-voltage connectors for copper conductors shall be of the solderless pressure type. Non-insulated connectors shall be smoothly taped to provide a waterproof insulation equivalent to the original insulation when installed on insulated conductors. On overhead connections of aluminum and copper, the aluminum shall be installed above the copper. Conductor-To-Insulator Attachments: Conductors shall be properly attached to insulators. For insulators requiring conductor tie -wire attachments, tie -wire sizes shall be as indicated in TABLE II below.

TABLE II. TIE-WIRE REQUIREMENT

CONDUCTOR	TIE WIRE
Copper (AWG)	Soft-Drawn Copper (AWG)
6	8
4 and 2	6
1 through 3/0	4
4/0 and larger	2
AC, AAAC, or ACSR (AWG)	AAAC or AAC (AWG) Any Size 6 or 4

C. Armor Rods: Armor rods shall be provided for AAC, AAAC, and ACSR conductors. Armor rods shall be installed at supports, except armor rods will not be required at primary dead-end assemblies if aluminum or aluminum-lined zinc-coated steel clamps are used. Lengths and methods of fastening armor rods shall be in accordance with the manufacturer's recommendations. For span lengths of less than 200 feet, flat aluminum armor rods may be used. Flat armor rods, not less than 0.03 by 0.25 inch shall be used on Number 1 AWG AAC and AAAC and smaller conductors and on Number 5 AWG ACSR and smaller conductors. On larger sizes, flat armor rods shall be not less than 0.05 by 0.30 inches. For span lengths of 200 feet or more, preformed round armor rods shall be used.

D. Low-Voltage Cables: Low-voltage cables shall be supported on clevis fittings using spool insulators. Dead-end clevis fittings and suspension insulators shall be provided where required for adequate strength. Dead-end construction shall provide a strength exceeding the rated breaking strength of the neutral messenger. Clevis attachments shall be provided with not less than 5/8-inch through-bolts. Secondary racks may be used when installed on existing wood poles and where matching existing construction if the span length does not exceed 200 feet. Secondary racks shall be two -, three-, or

four-wire, complete with spool insulators. Racks shall meet strength and deflection requirements for heavy-duty steel racks, and shall be either galvanized steel or aluminum alloy. Tops of insulator saddles shall be rounded and smooth to avoid damage to conductor insulation. Each insulator shall be held in place with a 5/8-inch button-head bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom. Racks for dead-ending four Number 4/0 AWG or four larger conductors shall be attached to poles with three 5/8-inch through-bolts. Other secondary racks shall be attached to poles with at least two 5/8-inch through-bolts. Minimum vertical spacing between conductors shall not be less than 8 inches.

3.6 TRANSFORMER INSTALLATION

A. Transformers shall be carefully installed so as not to scratch finishes or damage bushings. Transformers shall be installed in accordance with the manufacturer's instructions. After installation, surfaces shall be inspected and scratches shall be touched up with a finish provided by the transformer manufacturer for this purpose. Three-phase transformer installations shall be installed with proper phase sequence to match existing or as directed. Primary taps shall be set at 2-1/2% or as directed.

3.7 CONNECTIONS TO UTILITY LINES

A. The Contractor shall coordinate the work with the Contracting Officer and shall provide for all final connections to the electric lines at times and places as approved.

3.8 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

A. Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in Schedule 40 Rigid Galvanized Steel conduit to cable terminations. Conduits shall be secured to the poles by two-hole galvanized steel pipe straps spaced not more than 10 feet apart and with one strap not more than 12 inches from any bend or termination. Cables shall be supported by devices separate from the conduit, near their point of exit from the riser conduit. Conduits shall be equipped with bushings to protect cables and prevent water entry. Capnut potheads shall be used to terminate medium-voltage multiple -conductor cable.

3.9 CONNECTION TO BUILDINGS

A. Aerial Services: Connections to buildings shall be made at approximately the point indicated and shall be connected to the service entrance conductors. Supports at buildings shall be adequate to withstand required pulls, but in no case shall supports be rated less than 1,000 pounds. Drip loops shall be formed on conductors at entrances to buildings, cabinets, or conduits. Service -entrance conduits with termination fittings and conductors within the building, including sufficient slack for connection to aerial service cables, shall conform to the requirements of Section: 26 05 01, ELECTRICAL WORK, INTERIOR.

B. Underground Services: Connections to buildings shall be made at the point indicated and shall be terminated at the service entrance equipment terminals. Cable pulling shall be in accordance with Section 26 05 43, ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Service entrance conduits with termination fittings and conductors within the building shall conform to the requirements of Section 26 05 01,

ELECTRICAL WORK, INTERIOR.

C. Grounding: Noncurrent-carrying metal parts of equipment and conductor assemblies, such as luminaries, medium-voltage cable terminations and messengers, metal poles, operating mechanisms of pole top switches, panel enclosures, transformers, capacitors, recloser frames (cases) and other noncurrent- carrying metal items shall be grounded. All guys shall be connected to the pole ground conductor near the point of attachment to the pole. A pole ground electrode and ground conductor shall be provided as necessary. Additional grounding of transformer, equipment, neutral, and surge arrester grounding systems shall be installed at poles where such items are indicated.

1. Grounding Electrodes: A grounding electrode shall be installed at each pole as shown, connected to the system neutral and other pole top hardware as specified herein. Additional Electrodes installed shall be installed at transformers and equipment as shown. Grounding electrodes shall be installed as follows:

   a. Driven rod electrodes – unless otherwise indicated, ground rods shall be located approximately three feet out from base of the pole and shall be driven into the earth until the tops of the rods are approximately one foot below finished grade. Multiple rods shall be evenly spaced at least 10 feet apart and connected together two feet below grade with a minimum Number 6 AWG bare copper conductor.
   b. Pole butt electrodes -Pole butt electrodes shall not be used.
   c. Plate electrodes - Plate electrodes shall be installed in accordance with the manufacturer's instructions and ANSI C2 (2012) and NFPA 70 (2014).
   d. Additional electrodes - Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes will be up to three, 10 feet rods spaced a minimum of ten feet apart or a single extension-type rod, 3/4-inch diameter, up to 30 feet long, driven perpendicular to grade.

D. Grounding and Bonding Connections: Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors in compliance with UL 467 (2013), and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

E. Grounding Electrode Conductors: A single continuous vertical grounding electrode conductor shall be installed on each pole and connected directly to the grounding electrodes indicated on the drawings or required by these specifications. All equipment, guys, neutrals, surge arresters, and other items required to be grounded shall be connected directly to this vertical conductor. The grounding electrode conductor shall be sized as shown. Secondary system neutral conductors shall be connected directly to the transformer neutral bushings, then connected with a neutral bonding jumper between the transformer neutral bushing and the vertical grounding electrode conductor, as shown. Grounding electrode conductors shall be secured to wood poles at intervals not exceeding 2 feet. On concrete poles, a preformed galvanized steel strap, 5/8-inch wide by 22-gauge minimum by length, secured by a preformed locking method standard with the manufacturer, shall be used to support a grounding electrode

conductor installation on the pole and spaced at intervals not exceeding 5 feet with one band not more than 3 inches from each end of the vertical grounding electrode conductor. Bends greater than 45 degrees in grounding electrode conductor are not permitted.

F. Safety: The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, traffic lane control markers and danger signs to protect and warn personnel in the vicinity of construction or testing. The Contractor shall replace any devices or equipment which are damaged.

3.10 FIELD TESTING

A. General: Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer in accordance with Section 01070, “Contractor Quality Assurance/Quality Control.” The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field reports will be signed and dated by the Contractor.

B. Ground-Resistance Tests: The resistance of each grounding electrode system including each pole ground shall be measured using the fall-of-potential method defined in IEEE 81 (2012). Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number or electrodes must still be provided.

1. Single electrode – 25Ω.
2. Multiple electrodes – 10Ω.

C. Sag and Tension Test: The Contracting Officer shall be given prior notice of the time schedule for stringing conductors or cables serving overhead medium-voltage circuits and reserves the right to witness the procedures used for ascertaining that initial stringing sags and tensions are in compliance with requirements for the applicable loading district and cable weight.

D. Low Voltage Cable Test: When installed as part of an aerial or underground service under this section of the specifications, Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations of conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or cable grounded. The Minimum value of insulation shall be:

$$R_{M\Omega} = \frac{(Rated\ Voltage\ in\ kV + 1) \times 1{,}000}{Length\ of\ Cable\ in\ Feet}$$

E. Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

F. Pre-Energization Services: The following services shall be performed on the equipment listed below. These services shall be performed subsequent to testing but prior to the initial energization. The equipment shall be inspected to insure that the installation is in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at major equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation. If factory tests were not performed on completed assemblies, tests shall be performed after the installation of completed assemblies. Components shall be inspected for damage caused during installation or shipment and that packaging materials have been removed. Components capable of being both manually and electrically operated shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Items for which such services shall be provided, but are not limited to, are the following:

1. Switches
2. Transformers

G. Operating Tests: After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

3.11 ACCEPTANCE

A. Final acceptance of the facility will not be given until the Contractor has success fully completed all tests and after all defects in installation, material or operation have been corrected.

END OF SECTION 26 05 46

SECTION 26 11 13 – MAIN ELECTRIC SUPPLY STATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1, General Requirements Specification Sections, apply to this Section.

1.2 GENERAL REQUIREMENTS

A. Materials and Components: Materials and components of the same classification and rating shall be identical, and shall comply fully with applicable publications referenced herein. The term "components" shall include complete equipment and assemblies where references cover such items in total and shall not be construed to limit coverage to individual parts within the assembly or equipment. Refer to paragraphs "MATERIALS" and "COMPONENTS" for terminology and listing of materials and components (including equipment and assemblies) required. Materials and components shall be installed in accordance with the applicable requirements of NFPA 70 (2014), ANSI C2 (2012), approved and certified detail drawings including power system protective coordination studies, manufacturer's; installation instructions, and any other manufacturer's recommendations. Aerial design shall conform to ANSI C2 (2012) for medium loading districts, Grade B construction.

B. Standard Product: Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Design conformance tests for major pieces of equipment proposed for use on this project (Transformers IEEE C57.12.90 (2010), Switchboard IEEE C37.21 (2005) shall have been successfully performed at least three (3) years prior to bid date. Certified copies of ANSI, UL, NEMA, and other design tests required under standards shall be made available upon request to demonstrate compliance. Design tests for standards compliance shall have been made on the prototype or production sample of equipment proposed to be furnished under this contract and shall have been performed for the Manufacturer who will actually fabricate and guarantee the equipment to be furnished under this contract. Failure to furnish certified proof of compliance with design standards and tests, when so requested, will immediately disqualify equipment in question from further consideration for use under this contract. Nameplates shall be provided to identify all items of electrical equipment, including component parts of electrical assemblies, or major items of equipment.

1 Manufacturer's Nameplates: Manufacturer's nameplates shall be provided when required by applicable publications referenced, and shall contain the name of the manufacturer and information stipulated in the referenced standard. Power Transformers shall be provided with Nameplate C information shown in IEEE C57.12.00 (2010). Other major components of the station, not required to have a manufacturer's nameplate, shall be suitably identified by an approved type and size of nameplate to denote the name and designation that appears on approved detail drawings. In addition, dielectric-liquid-filled equipment shall be permanently

marked and shall state that the dielectric to be supplied is non-PCB classified with less than 1 part per million (ppm) PCB content.

2 Additional Nameplates: Additional nameplates shall be provided to identify cabinets, compartments, panels, units, other assembly components, and individual items of equipment not properly identified by a manufacturer's escutcheon, integral nameplate, or other approved methods. Nameplates shall suitably identify items of equipment by nomenclature or description as contained on contract drawings, in the specifications, or on approved detail drawings.

3 Nameplate Requirements: Manufacturer's nameplates, required by applicable publications, shall be of the size, material and finish standard with the manufacturer, except nameplates for power transformers (and voltage regulators) shall be of the stainless steel type. All other nameplates shall be the laminated, multicolor plastic type of an approved size. Plastic nameplates 1 inch by 4 inches or larger shall be engraved with numbers or letters not less than 3/16-inch in height. Characters on smaller nameplates shall be not less than 3/16-inch in height. Nameplates shall be not less than 3/4-inch by 2-1/2 inches in size unless otherwise approved. Nameplates shall not be obscured and must be securely attached in a conspicuous location.

C. Prevention of Corrosion: Metallic materials shall be protected against corrosion as specified. Aluminum shall not be used in contact with earth, or concrete. Aluminum shall be protected by UL listed connectors when connected to dissimilar metals. Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 (2009), and ASTM A 123 (2013).

D. Luminaires: Luminaires housings shall be fabricated from non-ferrous metals, with hot-dip galvanized mounting brackets and corrosion resistant hardware. The unit shall be factory finished with a weather-resistant finish that will withstand 200 hours exposure to the salt spray test specified in ASTM B 117 (2010). Finish color shall be the manufacturer's standard, unless otherwise indicated.

E. Unusual Service Conditions: Items furnished under this section shall be specifically suitable for the following unusual service conditions.

1. Seismic Category C: The equipment, as installed, shall be suitable for use in seismic category C, importance factor 1.

F. Verification of Dimensions: The Contractor shall be specifically responsible for the coordination and proper relation of the work to the site and to the work of each trade. The Contractor shall visit the premises to become thoroughly familiar with details of the work and working conditions, to verify dimensions in the field, and to advise the Contracting Officer of any discrepancy before performing any work.

G. Power System Protection Coordination Study: The Contractor shall submit for approval a complete Short Circuit and Protective Device Coordination Study for the specific equipment being provided. The study shall be submitted as a part of the submittal of the pertinent equipment and other protective devices to be supplied under this contract. No time extensions or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed by the Contractor for use under this contract shall be based on recommendations of the study. The Government shall not be held responsible for any changes to equipment, device

ratings or settings or additional labor for installation of equipment or devices ordered and/or procured prior to approval of this submittal. Available short-circuit currents shall be calculated using a digital computer with suitable software, for all equipment and/or protective devices in the new system to be supplied under this contract and shall include the nearest upstream and downstream devices in the existing system to assure compatibility with the existing system. The fault currents shall be calculated for both phase to phase and phase to ground conditions (MAXIMUM AND MINIMUM) and shall be considered for worst-case conditions for multiple sources which may feed the unit sub such as Primary sub 2, 3 and 1. A one-line diagram shall be included to clearly define the system included in the study. The diagram shall contain data on which calculations are based, conductor sizes and heat limits, equipment interrupting or withstand ratings, and device settings or ratings. A protective device coordination study shall be performed to determine the settings and/or ratings of all protective devices to be furnished under this contract that will optimize the selectivity between the new devices and the upstream and downstream devices in the existing system. The study shall include all devices in the path from the nearest upstream device in the existing source system to include the largest downstream device one level below that of the devices closest to the load ends of the new system. The coordination shall commence at the source protective device in the existing primary substation and end with the 12 KV protective device ahead of each distribution transformer. The study shall identify the short circuit rating of each service attached to each new or converted transformer and determine if the service short-circuit rating is adequate for the new system configuration. The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices, consistent with protection of equipment and conductors from damage from overloads and fault conditions. Worst-case loop connections shall be considered in systems where loop feed arrangements are to be used. All settings shall be clearly stated or tabulated and accompanied by time-current curves showing the coordination of the aforementioned devices. The study shall clearly show areas of non-coordination and shall make recommendations to improve or enhance system reliability, denoting as appropriate, where such changes would involve additions or modifications to the contract entailing additional cost to the Government. The Contractor shall calibrate and test all protective devices to be installed under this contract, and shall make all settings or adjustments as shall have been determined by this study after the study has been approved by the Contracting Officer, and prior to initially energizing the conductors and equipment. Any deficiencies in ratings or characteristics of any equipment or device specified to be supplied under this contract, which are revealed during the preparation of this study, shall be brought to the immediate attention of the Contracting Officer for resolution.

1.3 STATION DESCRIPTION

A. A new substation is to be constructed on a new site North side of building 4475. The new substation will provide power to the Central Chilled Water Facility through six pad mounted building transformers. The new substation will operate to convert the 46-KV Grounded Wye sub-transmission voltage for distribution at 12470GrdY7200 volts. The existing 46-KV line connecting Unit Sub 13 and Unit Sub 3 will be intercepted.

B. Transmission System Supply: Dual incoming supplies shall enter the station aerially and comply with the requirements of paragraph 2.4 “INCOMING LINES AND AERIAL BUSES.” The incoming lines shall be three-phase three-wire type having a voltage rating of 46-KV phase-to-phase. Incoming 46-KV line equipment shall be rated for a nominal

voltage class of 46 KV and shall have a BIL of not less than 250 KV. The available fault capacity of the 46-KV transmission system is 300 MVA. The 12470 line equipment shall be rated for a nominal voltage class of 15-kV and shall have a BIL of not less than 95 KV.

C. Station Type: The station shall be a primary substation type. The initial capacity of the substation is based on the 55/65 degree C single-stage cooled transformer capacity shown.

D. Outgoing Circuits: The number of outgoing distribution feeders shall be as shown. Outgoing circuits shall be three-phase four-wire type having a nominal voltage rating of 12.47 KV phase-to-phase. Outgoing circuits shall leave the stations underground. Outgoing circuits shall be three-phase, four-wire using URD type cable with a 33% concentric neutral routed to the riser pole shown. Outgoing circuit equipment beyond the transformer secondary breaker shall be rated for a nominal voltage class of 15 KV and shall have a BIL of not less than 95 KV.

E. Incoming and Outgoing Circuit Compliance: Aerial line circuits shall comply with the requirements of Section 26 05 46 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL. Underground circuits shall comply with the requirements of Section 26 05 43 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

1.4 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 “Submittal Procedures,” in sufficient detail to show full compliance with the Contract Documents. Documents shall be submitted for approval and shall consist of data and drawings identified in this section. Approval of materials and components shall be based on documents published by the manufacturer of the respective items of equipment, or other proof of compliance specified. Approval shall remain tentative pending complete compliance with all provisions of the contract that include the field installation, testing, and subsequent acceptance of equipment. The initial submittal of data and drawings for major items of equipment shall be made within 90 calendar days after the date of the Notice to Proceed. Resubmittal of revised documents requested shall be made within 45 calendar days after the return date of the reply of the prior submittal to the Contractor. Each document submitted shall be completely legible and printed, typed, or stamped to fully relate the documents to the contract provisions and any associated major item of equipment proposed. Any other manual alteration to copies of data or drawings made subsequent to printing may result in the disapproval of the documents as a suitable contract instrument.

B. Design Analysis, Studies and Data

1. Structural Design Analysis and Calculations:
2. Structural calculations prepared by a registered professional engineer shall be submitted proving that strength requirements for structures, anchor bolts, and foundations are adequate.
3. Foundation Design Analysis and Calculations:
4. Provide Foundation design analysis with sketches for structures and equipment to be supplied. See paragraph “Station Structure”.
5. Protective Device Study and Calculations:

6. Submit power system short circuit and system coordination study as required by paragraph “Power System Protection Coordination Study”.
7. Battery Calculations:
8. Provide station battery calculations as specified in paragraph “Station Battery Installation” (Preference is given to 150 AH Lead Acid Selenium Battery with 12 amp charger).
9. Lighting Calculations:
10. Provide Lighting calculations as specified in paragraph luminaires under paragraph heading “Miscellaneous Requirements”.
11. Manufacturer's Catalog Data:
12. Supplementary documents (cut-sheets) shall be furnished to demonstrate the accuracy and completeness of the lists of materials and components to be incorporated into assemblies such as switchgear, that items proposed comply fully with contract requirements, and are otherwise suitable for the application indicated. Such documents shall consist of data or drawings prepared by the manufacturer of individual items listed, or other proofs of compliance specified, including certifications and test reports.

C. Detail drawings shall be prepared by the manufacturers of assemblies of materials and components that constitute major items of station equipment. Such equipment includes the incoming line and station bus structures and integral equipment, transformers, power circuit breakers and switchers, switchboard, battery and battery-charger, cabinets, and any other assemblies shown or specified. Drawings shall be prepared to show the structural and electrical details and features of equipment as required to demonstrate full compliance with applicable provisions of the contract, and to facilitate the installation, operation, and maintenance of the station equipment.

D. Structural drawings (including foundations), prepared by a registered engineer, shall be furnished to show the structural or physical features of major items of station equipment and components of equipment or equipment assemblies and structures, including foundations or other types of supports for equipment and conductors. Those drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of station equipment and component parts of the equipment, and the relative arrangement of components and any physical connection of related components. Weights of equipment and components of equipment assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall further show the provisions for leveling, anchoring, and connecting all items of station equipment during installation, and shall include any recommendations made by the manufacturer of the equipment.

E. Electrical drawings shall include single-and-three-line diagrams of the station and station equipment, schematics or elementary diagrams of each electrical system; internal wiring and external connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of the switchboard, cabinets, panels, units, or other separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; and external connection diagrams that show the termination of wiring routed between separate items of station equipment. The manufacturer of the control switchboard coordinate and incorporate all elements of the relaying and control functions of the 46-KV fault interrupter switches, 12-KV vacuum breakers, Motor-

operated air switches, and supervisory control interface functions in the drawings required for submittal on the station control house and switchboard, SEE SECTION 26 11 14, "STATION SWITCHBOARD." The Electric al drawings, including the protective device coordination study (see Para. 1.2.G) shall be submitted in one complete submittal for a single approval action.

F. Material, Equipment, and Fixture Lists: Lists of items of materials and components or equipment proposed for incorporation into the work shall be prepared by the manufacturer of the major items of equipment, and shall include a reference item number for each separate item which shall be shown on drawings wherever the same item appears. Lists shall further include the quantity of each item proposed, the name of the manufacturer, a complete catalog, style, or a similar order number, as well as the manufacturer's data or catalog cut-sheet description of the item and any corresponding device number or description shown or indicated. The manufacturer's order number shall be complete and assigned either by the manufacturer or in accordance with the instructions of the manufacturer, and shall indicate any available accessory or optional features of the items that are required by the application for satisfactory operation of electrical equipment or systems.

G. Listing of Product Installations: When so requested, the Contractor shall certify in writing that materials and equipment to be supplied are products of manufacturers regularly engaged in the manufacture of such products and these products have been successfully used for a period of not less than 2 years prior to the date of the Invitation for Bid. Design conformance tests demonstrating that the proposed equipment has successfully passed industry standard design requirements shall be furnished in addition, if so requested, to show that the design of the proposed equipment was perfected at least 3 years prior to bid date. The names, addresses, and telephone numbers of at least 2 satisfied users shall be submitted if requested. Major items of equipment, and individual components furnished as an integral part of such equipment, shall be capable of being adjusted, calibrated, tested, and otherwise maintained, repaired, or replaced by one or more service organizations which, in the opinion of the Contracting Officer, are conveniently located in relation to the installation. The names, addresses, and telephone numbers of service organizations shall be submitted promptly, if so requested.

H. Reports: Test procedures and reports are required for the following tests and shall be furnished. Results of all factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications. Reports of tests on power transformers shall include the percent regulation and guaranteed efficiencies at full load, and at 75, 50, and 25 percent of full load, and will be in addition to impulse testing. Certification is required to verify each transformer has passed a production line impulse test consisting of one reduced-wave and one full-wave lightning impulse test on each fully insulated high-voltage terminal in accordance with IEEE C57.12.10 (2010) & IEEE C57.12.00 (2010). Pre-energization and operational checkout procedures shall be submitted not less than 30 calendar days before the field tests are scheduled to commence, and shall indicate each test proposed. Procedures are to be prepared as specified in paragraph "FIELD TESTS.” Field test reports shall be certified by the Contractor and shall demonstrate successful completion of pre-energization and operating tests and resistance-to-ground tests specified in paragraph “FIELD TESTS.”

I. Certificates of Compliance: Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories, Inc (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI) or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of, or listing by, UL will be acceptable as sufficient evidence that the items conform thereto. Either a certification or a published catalog specification statement, to the effect that the item has been designed and tested in accordance with the referenced ANSI standard, may be acceptable as sufficient evidence of item compliance. Certified copies of design tests must be provided when so requested. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as sufficient evidence that the item conforms thereto. When so requested, the Contractor shall submit a certificate from a recognized testing agency adequately equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications. Except as otherwise noted, the Contractor shall submit the transformer manufacturer's certification for each serial-numbered transformer that the insulating dielectric contains less than 1 ppm of PCB content. Certifications shall list the exact serial number of the transformers. The certifications will not be required when nameplates are suitably marked, as stated in paragraph "GENERAL REQUIREMENTS."

J. Manuals: Operation and maintenance manuals for the new substation shall be provided in accordance with Section 01 78 20, “Operation and Maintenance Data.” The manual shall include complete instruction and maintenance information on all manufactured equipment along with station one-line and associated 3-line interconnection diagrams in a bound book format. Station operational procedures shall be described, including startup, switching, steps for restoration of power to feeders or main sections after trip, capacitor bank settings, emergency troubleshooting of protective systems such as transformer differential and supervisory control systems and other information necessary for proper substation operation.

1.5 SERVICES OF TECHNICAL PERSONNEL FOR STARTUP AND TESTING

A. The Contractor shall provide one or more NETA certified engineers or technicians, (or representatives of the manufacturer for factory manufactured equipment) as required to complete the following services within a time period approved by the Contracting Officer. Services shall include any supervision required during installing, testing, and initial operation of the station. Qualifications of technical personnel proposed, shall be submitted for approval of the Contracting Officer at least 30 days prior to the date when services are to be commenced.

B. Inspection, Adjustment, and Testing: The following services are to be satisfactorily performed in relation to the inspection, adjustment (including calibrations), and testing of major items of equipment and materials and electrical components or individual items of equipment furnished as an integral part of the major items of equipment listed below. These services are to be performed subsequent to testing and determination that ground resistance values are acceptable, but prior to the initial energization of station equipment.

These requirements are in addition to performance of operational tests required by paragraph "FIELD TESTS." Major items of equipment shall be inspected to determine if they are adequately secured in place and installed in compliance with the recommendations of the manufacturer and as shown on the detail drawings. Terminations of conductors at station buses and at major items of equipment shall be inspected to ensure the adequacy of connections. Bare and insulated conductors between such terminations shall be inspected to detect possible damage during installation to the conductors or conductor insulation. Complete ACCEPTANCE TESTS in accordance with the International Electrical Testing Association (NETA) publication ATS-1999 shall be performed after the station installation is completed on all assemblies, equipment, conductors, control and protective systems as applicable to verify the integrity of all the systems. Such testing shall ensure that all field installed wiring is accurately and securely connected and complete and that insulation is adequate for the application. Components, including individual items of electrical equipment, shall be inspected to detect possible damage during installation or shipment, to ensure that components are adequately rated and installed for the specific application, and that packaging materials have been removed to free items for operation. Individual components capable of being both manual and electrical operation shall be operated manually prior to the first electrical operation. Components capable of being calibrated, adjusted, and tested shall be calibrated, adjusted, and tested in accordance with the instructions of the equipment manufacturer. Protective devices with adjustable features shall be adjusted, as necessary, to operate accurately at the settings determined during the power system protection coordination studies required by paragraph "GENERAL REQUIREMENTS." Upon completion of other tests but prior to energizing the station, all protective relays and associated components shall be tested by current injection and demonstrated to operate each breaker or associated system correctly and in accordance with the operations manual previously approved. The proper polarity and phasing of all current and voltage transformers for protective relaying and control systems shall be verified by flashing CT's and PT's and then confirming that the phase angles of the quantities required to operate each relay device are correct at the terminals of the protective relay itself using a relay test set with phase comparison capability. Items for which such services must be provided include, but are not limited to, the following major items of equipment and individual components of equipment listed:

1. Battery, station
2. Breakers, vacuum power circuit
3. Buses, station aerial
4. Cable, High voltage, Low voltage, and Control
5. Regulator, step-voltage
6. Switches, disconnect or load break
7. Switches, fault interrupter
8. Switchboard, station control
9. Switchgear, Metal Clad
10. Transformers, substation.
11. Transformers, instrument

C. Instruction: Upon successful completion of the field tests specified, the services of the Switchboard manufacturer's technical personnel (and others as necessary) shall be provided for a period of approximately 12 hours to instruct representatives of the Using Agency in the operation and maintenance of the station equipment, protective relaying and control systems.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall conform to the following requirements. Where the words apparatus, assemblies, devices, equipment, items, or parts are used herein they shall be considered equivalent to the use of the term materials and shall include the materials listed below.

B. Annunciators: ISA 18.1 (2004).

C. Bushings: IEEE C57.19.00 (2004) and IEEE C57.19.01 (2005).

D. Conductors

1. Bare Bus: Copper per ASTM B 188 (2010) or mechanically and electrically equivalent aluminum per ASTM B 317 (2007). Supports for bus, IEEE C37.32 (2002).
2. Concentric-Lay-Stranded Wire: Copper, ASTM B 8 (2011) or equivalent aluminum, ASTM B 231 (2012).

E. Conduits, Rigid Metal: UL 6 (2007).

F. Insulators

1 Apparatus: NEMA C29.9 (2013).
2 Suspension: NEMA C29.2 (2013).

G. Tests: NEMA C29.1 (2012).

2.2 COMPONENTS

A. Components shall conform to the following requirements. Where the words apparatus, assemblies, devices, equipment, items, or parts are used herein they shall be considered equivalent to the use of the term components and shall conform to requirements listed below.

B. Luminaires: UL 1598 (2008).

C. Metal Halide Lamps: NEMA C78. 380 (2007).

D. Metal Halide Lamp Ballasts: NEMA C82.4(2003).

E. Circuit Breakers & Fault Interrupter Switches

1. High-Voltage Power: IEEE C37.04 (2006), IEEE C37.32 (2002), NEMA C37.54 (2010), IEEE C37.09 (2009), NEMA SG 4 (2013).

F. Grounding and Bonding: IEEE 142 (2007).

1. Equipment: UL 467 (2013).
2. Wire: ASTM B 8 (2011), soft-drawn copper; ASTM B 231 (2012), aluminum.

G. Hardware: Ferrous metal threaded items shall conform to ASTM A 153 (2009) and miscellaneous non-threaded items shall conform to ASTM A 123 (2009); other equivalent protective treatment, as required by ASTM A 123 (2009) or ASTM A 153 (2009), or ferrous metals designed to meet ASTM Standards covering corrosion-resisting steel, will be permitted if approved in writing.

H. Relays, Electric Power Apparatus: IEEE C37.2 (2008) and IEEE C37.90 (2004), IEEE C37.90.1 (2012).

I. Station Equipment Items

1. Cabinets: Enclosures, UL 50 (2007). Finish colors, ANSI Z55.1 (1973) with either No. 24 (dark gray) or No. 70 (sky gray) for outdoor cabinets and No. 61 (light gray) for indoor cabinets, unless otherwise specified. The finish color of outdoor equipment shall be the same unless otherwise approved.

J. Metal Structures: ANSI standards for station design with members conforming to NEMA TT1 (1983) for tubular construction or equivalent H/I-beam construction. Structural steel and miscellaneous items; ASTM A 36 (2012), ASTM A 572 (2013), ASTM A 575 (2013), ASTM A 576 (2012), or ASTM A 633 (2013), or equivalent aluminum.

1. Padlocks: Padlocks shall conform to FS A-A-1928C (2007).
2. Signs, Danger, High-Voltage: NEMA Z535.2 (2011).

K. Step-Voltage Regulators: IEEE C57.15 (2009).

L. Surge Arresters: IEEE C62.11 (2012) for the zinc-oxide type suitable for outdoor installations.

M. Switches

1. Group-Operated: IEEE C37.30 (1997), IEEE C37.32 (2002), IEEE C37.34 (1994).
2. Stick-Operated: IEEE C37.30 (1997), IEEE C37.32 (2002), IEEE C37.34 (1994).
3. Switch Stick Length: IEEE C37.32 (2002).

N. Transformers

1. Control Power: IEEE C57.12.01 (2012).
2. Instrument: NEMA C12.11 (2014) and IEEE C57.13 (2008). NEMA SG 4 (2013) for current transformers used with or on circuit breakers exclusive of indoor circuit breakers used in power switchgear assemblies in accordance with IEEE C37.20.2 (2005).
3. Substation Power Type: IEEE C57.12.10, IEEE C57.12.90 (2010), IEEE C57.12.00 (2010).

O. Testing of Liquid-Insulated Types for PCB Content: ASTM D 923 (2007) and ASTM D 3304 (1984) in lieu of transformer nameplate marking or manufacturer's certificate specified.

P. Wiring Devices, General Purpose: NEMA WD 1 (2010).

2.3 STATION STRUCTURES

A. Station structures shall be of steel. Steel structural items shall conform to recognized industry standards for STRUCTURAL STEEL. Structures, except for incoming primary lines, shall be of the low-profile type. Structures shall utilize tubular or H/I-beam support elements; lattice type supports are not acceptable. Structures shall be provided as indicated and shall be designed for a maximum tension of 10000 pounds per conductor for 46-KV dead-ends, 6000 pounds per conductor for 12 KV dead-ends and 1500 pounds per conductor for slack span supports. Overhead neutral or static wires shall be counted as conductors in determining strength requirements. General configurations are indicated; exact dimensions and arrangements may be varied, dependent upon any site limitations, to permit use of a manufacturer's standard equipment and structures. Air terminals, not less than 6 feet in length, shall be provided on each structure column for lightning protection. Static wire brackets for incoming overhead ground wires shall be provided on each incoming dead-end line structure and elsewhere as indicated.

B. Apparatus Load Coordination: Structures shall be coordinated to the static, operating, and dynamic loads of the apparatus supported. Structures shall be constructed in accordance with the switch manufacturer's recommendations, unless otherwise shown.

C. Structure Design: Calculations shall be made by a registered engineer. Detail drawings shall show markings of units for placement, location and sizes of attachments, and complete data on fabrications.

D. Structure Finishes: Steel structures shall be hot-dip galvanized in accordance with ASTM A 123 (2013) after drilling is completed and shall not be painted.

E. Structure Foundations: Structure foundation design shall be prepared by a registered engineer to coordinate with the structure proposed. Maximum earth-bearing pressure shall be figured at 2000 psf. Each column shall be bolted to a concrete foundation by at least four bolts properly spaced to transmit structure stresses to the foundation. Diameters and lengths of foundation bolts shall be as recommended by the structure manufacturer. Bolts shall be embedded in concrete in a manner to develop their full strength. Anchor bolts shall be accurately set in foundations using templates supplied by the structure manufacturer. When concrete has cured, structure base plates shall be leveled and grouted in place. Columns shall then be set on base plates, leveled on foundations, and secured with holding nuts. Foundation reinforcement detailing and placement shall conform to CRSI “Manual of Standard Practice.” Concrete shall conform to ASTM C 94 (2014). Concrete work shall conform to ACI 304R (2009). Compressive strength in 28 days shall be 4,000 psi. Total air content of exterior concrete shall be between 3.5 and 7 percent by volume. Slump shall be between 2 and 5 inches. Concrete shall be cured for 7 days after placement.

2.4 INCOMING LINES AND AERIAL BUSES

A. Incoming Line Connections: The upper incoming line voltage shall be 46 KV, phase to phase. All components, installations, and connections shall be furnished by the Contractor.

B. Provision for Connection of Incoming Line Conductors: Incoming line conductors shall be provided under Section 26 05 46 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL

but connections to suspension insulators shall be provided under this section of the specifications.

C. Aerial Buses: Aerial buses within the station shall consist of bare conductors supported by suspension insulators, apparatus post insulators, and equipment as indicated.

1. Conductors: Conductors shall be copper or mechanically and electrically equivalent aluminum shape, but all aerial conductors used in the station shall be of the same composition. Conductors shall provide a minimum ampacity equivalent to 2-inch copper heavy pipe size (schedule 80) bus, except as otherwise indicated. Span lengths shall be based on a limiting deflection of 1/150 for spans having two supports and 1/200 for spans having three supports, under maximum wind, ice, and short-circuit loadings, including suitable allowances for any taps. Where required, larger or stronger bus shall be installed to maintain specified deflections for the indicated span lengths. Other bus shapes for electrical conductors may be used if detail drawing submittals indicate equivalent ampacity and strength. Short connections, consisting of bare stranded conductors of equivalent bus ampacity, may be used between incoming line conductors and buses or between buses and equipment. Copper flexible braid or aluminum strap expansion couplers, as required to match the bus material shall be installed in bus runs where required to allow for expansion and contraction.
2. Suspension Insulators: Suspension insulators of the wet porcelain type shall be provided for dead-end incoming line conductors. Suspension insulator strings and string supports shall provide a mechanical strength exceeding the ultimate strength of each dead-end conductor. Minimum ratings of suspension insulators shall be not less than NEMA C29.2 (2013) Class 52.3 or 52.4. Each suspension string shall have not less than five insulators in tandem for the 46 KV lines and not less than two insulators in tandem for the 12470 volt lines.
3. Apparatus Post Insulators: Apparatus post insulators of the wet porcelain type shall be provided as required to support conductors, and their mechanical strength shall exceed the ultimate strength of the conductor supported and, where necessary, high-strength or ultra-high-strength insulators shall be provided. Minimum ratings of apparatus post insulators shall be not less than specified in NEMA C29.9 (2013), Technical Reference Number 216.

D. Incoming Line Surge Arrester Protection: The station class surge arresters, suitable for an grounded system (42 KV MCOV) and for the applicable incoming line voltage, shall be provided on each phase of the 46 KV incoming line circuit, and mounted on station structures as shown.

2.5 INCOMING LINE SWITCHES

A. The incoming line switches shall be of the outdoor weatherproof group-operated, motorized or manual type or stick (hook)-operated single pole type as indicated.

B. Group-Operated Type: This type shall be three-pole, single-throw, with either tilting or rotating insulators and shall be provided with a mechanism that opens the three phases simultaneously. The switches shall be of the vertical-break or side-break type, for horizontal upright or vertical mounting as indicated, unless the manufacturer recommends a different type for a specific application. Contacts shall be of the high-pressure type designed to ensure continuous satisfactory contact. Contact surfaces shall

be silver. The switching device supplied should be of the fault interrupter, load interrupter or disconnecting type and manually or motor operated as indicated. The switch operating mechanism, handle, and other items required shall be provided, as necessary, for manual operation from the ground and shall include provisions for connection of ground cables and padlocking in both the open and closed positions.

1. Ratings: Ratings at 60-Hz and rated maximum voltage shall be for a momentary asymmetrical current of 61 KA rms, a 3-second current of 40 KA rms, a continuous current of 1200 amperes rms (or as shown), a rated maximum voltage of 48.3 KV, a nominal voltage class of 46 KV, and a BIL of 250 KV.
2. Fault Interrupter Type: This type shall have sulfur hexafloride (SF6) interrupters capable of interrupting currents up to 4000 A rms Symmetrical at rated voltage in accordance with Power Circuit Breaker standards IEEE C37.04 (1994) and IEEE C37.09 (2007), and in accordance with IEEE C37.30 (1997), an operating life expectancy of 2000 full load close/open operations. The switch shall be pedestal-mounted or as indicated. The switch and associated relaying and control shall be suitable for use on the 46 KV ungrounded system, connected as indicated on the drawings with control and relaying located in the Station Control House Switchboard. The functional requirements and specifications for relaying and control components shall be in accordance with, "MAIN CONTROL SWITCHBOARD."
3. Load Interrupter Type: This type shall have interrupters capable of interrupting currents up to the continuous current rating of the associated switch and, in accordance with the requirements of IEEE C37.30 (1997), an operating life expectancy of at least 2000 full-load close/open operations.
4. Manual Operated Disconnect Type: This type, used as a bypass, shall be provided with quick-break arcing horns adequately rated for interrupting transformer exciting currents or line charging currents, dependent upon the application. A permanent warning sign having letters at least 2 inches high and reading as follows: "WARNING – DISCONNECTING SWITCH – DO NOT OPEN UNDER LOAD" shall be mounted on the switch operating mechanism. The switch operating handle shall be located approximately 3 feet 6 inches above its grounded platform plate. Insulation of the switch shall include an insulated vertical shaft.
5. Motor-Operated Type: Each type switch where indicated shall have a 125 volt DC stored energy motor operator and a manual operating mechanism. The load-break type shall have an opening and closing operating time of not more than 10 seconds for each operation. The fault interrupting type switch shall have a 2 second open/close time for each operation and a shunt trip solenoid to allow remote trip capability with a maximum interrupting time of 8 cycles.

    a. Operation: The operating mechanism shall permit both manual and electrical operation of the switch at its operating mechanism cabinet, and electrical operation by the SEL 9510 control switch or SEL 351S located in located in the Station Control House Switchboard. The operating shaft or operator cabinet shall be clearly and permanently marked to indicate continuously the positions of the switch. An externally operable decoupler shall be provided at or near the point of entrance of the shaft into its operator housing to permit disengagement of the shaft for inspection, tests, maintenance, or repair of equipment located within the operator enclosure. Remote on/off switch with indicating lights (SEL 9510 control switch or SEL-351S) shall be provided on the station switchboard. Dry contacts shall

be, provided for open/close and a/b indicating contacts wired to the supervisory control interface panel in the Station Control House.

b. Operating Mechanism Cabinet: The maintenance-free, weatherproof housing shall be mounted where indicated or as suitable for the required operation. The electrical devices listed below shall be adequately rated for the application and shall be suitable for the low-voltage direct current available as specified. Unless otherwise noted, manufacture's standard devices for the rating specified shall be provided and shall include the following:

1) Local and remote toggle switch located in the motor operator control
2) A motor-operation counter.
3) Shaft travel limit switches and any required safety devices.
4) A light wired in series with a cabinet door-actuated switch, so that the light is energized only when doors are open.
5) A heater with a control thermostat set to energize the heater to prevent condensation within the cabinet over an ambient temperature range of minus 20 to 104 degrees F. Heater shall be protected by a guard.
6) A motor control contactor, with relays, solenoids, and any other control devices required.
7) Fuses as suitable for the operating voltage & protection of the control, heater, and light circuits.
8) A minimum of four spare auxiliary relay contacts, two normally open and two normally closed, wired to supervisory interface terminals.
9) An interface terminal block wired to permit remote open and close operations of the switch for supervisory control connections using dry contacts.
10) A factory installed SEL-2505 I/O module (P/N 2505314XX) shall be installed in the breaker with the open-close circuits and remote-local switch contact wired to it. (1) 52A and (1) 52b contact shall be wired to the module for “Trip Coil Failure” logic. 125Vdc shall be wired to the module to wet the contacts. Each SEL-2505 will be fiber optically connected back to respective SEL-351S relay located in the control building via required 200 micron weather proof fiber optic cable SEL-C805G020VVX075. Distance is approximate. It is the general contractor’s responsibility to investigate & provide the proper length fiber optic cable.

6. Grounded Iron Platform Plate: The group-operated switches shall be provided with a grounded platform plate located where the switch operator would stand to manually operate the switch. The plate shall be sized so that the operator can manually open and close the switch through the full required ranges of movement without stepping off the plate with either foot while making the normal movements. The plate shall be constructed of hot-dip galvanized iron at least 1/4-inch thick and shall be at least 4 feet in length by 2 feet 6 inches in width. The plate shall be laid on finished grade and so secured that it cannot be accidentally displaced. Two ground clamps shall be provided on the plate on the side adjacent to the switch operating mechanism. Each clamp shall be connected to the station grounding grid

with a No. 4/0 AWG bare copper wire. Separate clamps and a flexible copper braid conductor shall be used to connect the plate to the switch operating handle mechanism. The cross sectional area of the braid shall be equivalent to a Number 4 AWG conductor.

C. Stick {Hook} Operated Type: This type shall be a stick-operated, single-pole, single-throw, vertical- break switch suitable for vertical or horizontal underhung mounting as indicated.

1 Ratings: Ratings at 60-Hz and rated maximum voltage shall be for a momentary asymmetrical current of 61 KA rms, a 3-second current of 40 KA rms a continuous current of 1200 amperes rms or as shown, a rated maximum voltage of 48. 3 KV, a nominal voltage class of 46 KV, and a BIL of 250 KV.

2 Switch (Hook) Sticks: At least one switch stick of adequate length shall be provided, and where switches mounted at different elevations require different lengths, additional switch sticks shall be provided as necessary.

D. Miscellaneous: One set of special tools, as necessary for servicing, shall be provided.

2.6 POWER (VACUUM) CIRCUIT BREAKERS

A. 15 kV Distribution Breaker: The circuit breakers for the 12.47KV circuits shall be of the outdoor three-pole type; designed, manufactured, and tested in accordance with NEMA SG4 (2013) and all applicable ANSI/IEEE standards. Nominal voltage shall be 12.47 KV; rated maximum voltage shall be 15.5 KV RMS; rated continuous current shall be 600 Amps RMS; rated short-circuit current shall be 16 KA RMS; closing and latching capability shall be 32 KA RMS, 54 KA peak; low-frequency insulation level shall be 50 KV RMS; and the impulse crest (BIL) shall be 110 KV RMS. Ratings for this equipment shall reflect current industry standards, and deviations from the specified ratings will not be considered without evidence that the deviations are consistent with current industry standards and will be adequate for this installation.

B. Basic Requirements: The circuit breaker shall be equipped with multi-ratio bushing-type current transformers of the type specified below and shown. The quantity of current transformers shall be as indicated. The operating mechanism shall be motor-charged-spring type and housed in a low maintenance, weatherproof cabinet. The operating mechanism shall permit electrical tripping and closing at the operating mechanism cabinet and remotely, and manual tripping at the operating mechanism cabinet. Control voltage for close and trip operations shall be 125 volts dc. 120/240 volt 1-phase, 3w AC may be used for auxiliary functions at contractors' option. Each breaker shall be provided with relaying, instrumentation and control devices shown, with all instruments and relays for protective and remote control operation mounted in the station control house switchboard enclosure. Each breaker shall be provided with two trip coils.

C. Operating Mechanism Cabinet: The cabinet shall house the electrical devices listed below, which shall be adequately rated for the application and shall be suitable for the low-voltage alternating or direct current available as shown or specified. Unless otherwise noted, manufacturer's standard devices for the rating specified shall be provided and shall include the following:

1. A breaker mechanical position indicator.

2. A light wired-in series with a cabinet door-actuated switch so that the light is energized only when doors are open.
3. A heater with a control thermostat set to energize the heater to prevent condensation within the cabinet over ambient temperature ranges from minus 20 to 104 degrees F and wired in series with a cabinet door-actuated switch, so the heater is de-energized when doors are open.
4. An operator charging motor with thermal-overload relays.
5. A motor control contactor with relays, solenoids, and any other control devices required.
6. Necessary motor-alarm and interlock switches.
7. One-pole or two-pole thermal-magnetic molded-case circuit breakers as suitable for the operating voltage for control, heater, and light circuits.
8. A minimum of four spare auxiliary relay contacts, two normally open and two normally closed, wired to interface terminals.
9. Terminal facilities properly wired for devices installed in the cabinet, and to permit corresponding connections of incoming conductors from remote items of equipment.
10. Metal holder inside cabinet with instruction books and a complete set of drawings.
11. A local-remote selector switch, switch position indication lights, and a manual pull to trip handle.
12. Provide at least four #10 AWG spare conductors for control wiring between the breaker cabinet to the MAIN CONTROL SWITCHBOARD.

D. Current Transformers: Multi-ratio bushing type current transformers shall be provided in circuit breaker bushing compartments for protective relaying functions as shown. Multi-ratio units shall have a relaying accuracy voltage class of ClO0. Transformers shall be set as indicated, with maximum tap for full breaker amp rating or as shown. The continuous thermal-current rating factor shall be not less than 1.25. Other thermal and mechanical ratings of current transformers and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. The BIL rating shall be not less than the corresponding BIL rating of the associated bushing. Each terminal of current transformers to be used for metering or relaying purposes shall be connected to a short-circuiting terminal block in the breaker operating mechanism cabinet and in the control house. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accidental open circuiting of the transformers while energized. Wiring to relays shall be in accordance with , "MAIN CONTROL SWITCHBOARD," except that wiring for CT's shall be run in individual conduit #10 AWG minimum wire size.

2.7 POWER TRANSFORMER

A. The power transformer shall be of the 55/65 degrees C rise, three-phase, two-winding, mineral-oil-immersed type and shall be solidly grounded. The transformer shall use cylindrical-concentric wound copper coils. The manufacturer shall have documented ANSI/IEEE THE MANUFACTURER SHALL GUARANTEE LOSSES WHICH SHALL NOT EXCEED THE FOLLOWING: 7000 WATTS NO LOAD, FULL VOLTAGE; 44000 WATTS TOTAL AT FULL LOAD, RATED VOLTAGE AND CURRENT. Transformers that exceed guaranteed losses by more than 5% after final testing will be rejected and replaced at contractor expense. The Manufacturer shall have successfully performed Short-Circuit Proof tests on an essentially identical design of equal or larger rating prior to 3 years before bid date and shall provide certified test reports on the test if so

requested (see Standard Products under paragraph J General Requirements). The insulating dielectric shall not contain more than 1 ppm of PCB content, with that fact certified or the transformer nameplate marked accordingly, as specified. The oil preservation system shall be of the inert-gas pressure type. Single-stage, forced-air-cooling shall be provided utilizing automatic control of the auxiliary cooling equipment. Automatic controls, motors, heaters, and their protective devices shall be adequately rated for the application and shall be suitable for the alternating current available as shown or specified. Radiator isolation valves shall be provided for bolted-on radiators. The entire enclosure shall meet or exceed mounted equipment paint requirements and IEEE C57.12.29 (2014) for finish requirements for coastal environments and be so certified by the manufacturer. The color of the transformer case and auxiliary items shall match the color used for switchgear and cabinets as specified for cabinets in paragraphs "MATERIALS" and "COMPONENTS."

B. Ratings: Ratings at 60 Hz shall be for a high-voltage of 46 KV Delta at a BIL of 250 KV, a low-voltage of 12.47Y7.2kV at a BIL of 110 KV, a 55° C capacity of 7500/9375 (OA/FA) KVA, and a percent impedance of 8 percent (Nominal).

C. Monitoring: A field installed SEL-2414 Transformer Monitor model # MOT241421ACA9X743A1130 shall be used for cooling control and local annunciator. It shall be installed in control cabinet. Input to the device shall include the transformer alarms and RTD inputs for oil, winding and ambient temperature. Alarm inputs include sudden pressure, oil levels, and nitrogen pressure, etc. The SEL-2414 outputs will be used to control the transformer cooling fans, and to initiate a winding temperature trip timer. This module will send its information to the SEL3332 by a fiber optic interface. Transformer manufacturer or contractor will supply the (1) SEL-2810MR transceiver. One to be installed on Port 3. SEL engineering will provide logic to use one port for “Mimic Bits” and the other port is to report to the SEL-3332. Mirror Bits channel is to report to the 2100 logic processor via the ST fiber port.

D. Liquid Level: A magnetic type liquid level indicator shall be as described and shall be include low level alarm contacts per 5.1.10 of IEEE C57.12.10 (1210). Liquid level indicators shall be provided and wired into the SEL-2414. Liquid level indicator to alarm at least 2 inch before the critical oil level is reached.

E. Control of Auxiliary Cooling Equipment: Controls of auxiliary cooling equipment shall combine the transformer temperature indicator and the transformer thermal relay, Device 49, in one unit suitable for responding either to the transformer's top liquid or winding temperature, and shall include auxiliary devices necessary for sensing temperature changes. These devices shall be mounted on a transformer in a suitable housing so that maintenance is possible without removing the transformer cover. Relay Device 49 shall have three electrically independent contacts operating and wired as follows:

1. First set of contacts set to close at 80° C and wired for starting first-stage forced-air-cooled fans.
2. Second set of contacts set to close at 85° C and wired to spare terminals in the transformer terminal cabinet and to the supervisory control interface panel in the metal-clad switchgear.
3. Third set of contacts set to close at 120° C and wired to energize an auxiliary relay, Device 49X. The relay shall be mounted in the transformer terminal cabinet or the metal-clad switchgear. Device 49X shall be properly rated and equipped with not

less than three normally open and three normally closed sets of electrically independent contacts. One set of contacts shall be wired to trip the main transformer secondary circuit breaker and incoming line incoming line fault interrupter lockout. The second set of contacts shall be wired to annunciate excessive transformer temperature and the consequent load interruption to supervisory control interface panel in the metal clad switchgear.

F. Surge Arresters: Surge arresters of the station class, suitable for the associated transformer primary line-to-ground voltage, rated 42 KV MCOV, shall be mounted next to each high-voltage bushing on a transformer tank-mounted bracket and connected to a surge arrester ground pad. Discharge counters shall also be provided and mounted on the brackets.

G. Neutral Grounding: The secondary neutral bushing of the transformer shall be solidly bonded to the station ground mat with 500 Kcmil copper conductors which shall then continue unbroken to bond regulator, CPT, main breaker and feeder pull-off structures directly to neutral bushing.

H. Bushings and Current Transformers: Primary and secondary cover bushings for high- and low-voltage line and neutral connections shall conform to the requirements of IEEE C57.19.00 (2004) and IEEE C57.19.01 (2005) and shall have the same BIL as the associated power transformer's high- and low-voltage BIL ratings respectively.

1. Current Transformers: Multi-ratio bushing type current transformers shall be installed on power transformer bushings, two per phase on each high-side bushing and one per phase on the low side bushings (spares). Transformers shall be 600/5 set at the indicated ratios. Multi-ratio units shall have a relaying accuracy voltage class of 400 for either a C or T classification. BIL ratings shall be not less than the bushing rating of the associated power transformer. Transformer secondaries shall be provided with short-circuiting terminal blocks located in the power transformer terminal cabinet and automatic open circuit protectors shall be installed across transformer secondary leads. Wiring to relays shall be in accordance with SECTION 26 11 14, "STATION SWITCHBOARD," except that wiring for CT's shall be run in individual conduit, Number 8 AWG minimum wire size.

I. Accessories: Transformers shall be provided with the accessories listed below. Contact devices for remote control features shall be adequately rated for the application and shall be suitable for the low-voltage alternating current available, as shown or specified.

1. A tap-changer for de-energized operation provided with a padlock.
2. A liquid-level indicator, Device 63L, with one set of contacts wired in series with the coil of an auxiliary relay, located in the transformer terminal cabinet. The auxiliary relay, Device 63LX, shall have not less than three normally open and three normally closed sets of adequately rated and electrically independent contacts. One set of relay contacts shall be wired to annunciate low liquid-level via the supervisory control panel.
3. A pressure-vacuum gauge when the transformer is provided with a sealed-tank or gas-oil-seal oil preservation system.
4. Drain and filter valves.
5. Lifting, moving, and jacking facilities.
6. Two transformer case grounding lugs suitable for termination of No. 4/0 AWG bare

copper cables.

7. Primary bushing-mounted current transformers specified.
8. Sudden Pressure Relay, Device 63S, connected via Auxiliary time-delay relay, Device 63X, located in the transformer terminal cabinet or metal-clad switchgear. A set of contacts of Device 63X shall be wired to energize the transformer lockout relay, Device 86T. In turn, contacts of Device 86T shall be wired to annunciate abnormal transformer pressure to the supervisory control panel and open the main secondary breaker and the fault interrupter switch on the primary side of the faulted transformer.

J. Miscellaneous Items: Miscellaneous items to be provided for a transformer shall include the following:

1. A weatherproof transformer terminal cabinet for circuits that are connected to devices not mounted integrally on a transformer, but remotely such as in switchgear units plus terminal blocks for supervisory control interface circuits. The gauge of metal for the cabinet shall be the manufacturer's standard. Color of the cabinet shall match the color of the associated transformer. The door or doors of the cabinet shall be equipped with suitable locking provisions.
2. Raceway connections and associated interface wiring between a transformer interface terminal cabinet and any remote devices which operate in conjunction with transformer-mounted devices, including necessary wiring for remote control features. Remote control features include the tripping of associated primary and secondary circuit breakers and the actuation of the associated annunciator circuits by the indicated transformer control or accessory contact, both locally and to the supervisory control interface panel.

2.8 CONTROL AND INSTRUMENT TRANSFORMERS

A. Control Power and Instrument Transformers shall be of a type suitable for mounting on the outdoor structure or bus support structure shown and shall have a BIL not less than that of the associated equipment. Polarity marks on instrument transformers shall be visually evident and shown on shop drawings and connection diagrams. Control Power Transformers shall meet requirements of Outdoor Distribution Transformers in SECTION 26 05 46 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.

B. Potential Transformers: Potential transformers shall have indicated ratios. Units shall have an accuracy class rating of 0.3Z. Transformers shall be of the dry insulated type, having current limiting fused disconnects in both primary and secondary circuits. Transformers shall have BIL rating of the associated circuit equipment.

2.9 STEP -VOLTAGE REGULATOR

A. The voltage regulator shall be of the outdoor, self-cooled, 55/65 degrees C temperature rise, single-phase, station-type. Windings and the load-tap-changing mechanism shall be mineral-oil -immersed. When operating under load, a regulator shall provide plus and minus 10 percent automatic voltage regulation in approximately 5/8 percent steps, with 16 steps above and 16 steps below rated voltage. Three single - phase units shall be provided; the use of two single-phase units connected open delta is not acceptable. Automatic control equipment shall provide Class 1 accuracy. Surge protective devices shall be suitable for a grounded system and for the associated regulator voltage.

B. Ratings: Ratings at 60 Hz shall be for a voltage of 7200 volts, a BIL of 110 KV, a capacity of 333 KVA, and a current of 463 amperes rms.

C. Switches: Switches shall be of the outdoor, stick-operated, single-pole, single-throw, vertical-break type suitable for the indicated mounting. Switches shall be of a type designed to provide bypass of a single - phase regulator circuit by an integral sequence which always occurs when each switch is opened or closed. Each opening sequence shall initially bypass the single-phase regulator circuit, then open the input and output circuits, and finally interrupt the exciting current. Opening any single-phase regulator circuit shall not be possible until after the bypass circuit is closed. Unless the voltage regulator is equipped with integral line surge protective devices, surge protectors shall be mounted across terminals of each switch rated up to 25 KV.

1. Ratings: Ratings at 60 Hz and rated maximum voltage shall be for a momentary asymmetrical current of 40 KA rms in the closed position and 40 KA rms in the bypass position, a continuous and interrupting current of 600 amperes rms, a rated maximum voltage of 15 KV, a nominal voltage class of 14.4 KV, and a BIL of 110 KV.

D. Miscellaneous: In addition to IEEE C57.15 (2009) standard accessories and components, the accessories and components listed below shall be provided.

1. Regulator Sub-Base: The regulator sub-base shall elevate the lowest live part (base of bushing) of the regulator to a height of at least 9 ft -6 inches above the concrete pad on which it is mounted.
2. Single Phase Units: Single phase units shall be provided with additional components and accessories required by IEEE C57.15 (2009) for three-phase units.
3. Surge Arresters: Surge arresters of the Distribution Class shall be mounted next to each incoming line bushing on a regulator tank-mounted bracket and connected to a surge arrester ground pad mounted on the regulator tank.

2.10 CONTROL HOUSE SHELTER

A. The control house shelter shall consist of a 15ft X 26ft (nominal size) prefabricated concrete shelter manufactured by VFP Inc. The shelter layout shall be approximately according to the drawing attached. The shelter shall be rated for a minimum of 150mph wind resistance. Control house and all installed equipment shall be designed to meet seismic zone 1. The shelter shall include a pre-installed 200 amp single-phase 120/240VAC main electric panel with conduit raceway for its service entrance. The panel shall be provided with at least six breaker space for future use. Service entrance shall be from dual station transformer and shall include an automatic switch to switch from the preferred transformer to the backup (second) transformer. A surge suppressor shall be installed in the main electrical panel and shall be sized to provide complete protection to all devices connected within the shelter. The shelter shall include a DC electrical panel. DC panel shall contain space for six future breakers, in addition to those needed for initial installation. A raceway or exterior grounding lug shall be provided for grounding conductor to be connected to external ground. The shelter shall include pre-installed interior fluorescent lighting fixtures suitable for the internal area. The light fixtures shall be guarded by wire mesh or other suitable method to prevent mechanical damage to the

fixtures or bulbs. The shelter shall also be provided with separate battery powered lighting system. The battery powered lights shall be 60-watt, clear incandescent lamp with glass or wire shields. The battery lighting system shall operate off the station batteries. The shelter shall include one 36 inches X 80 inches steel entry door. Door shall be fitted with an automatic closure device with a “hold-open” feature and shall be provided with Sergeant door lock, keyed as directed in the field. Double panel thermal windows shall be provided, three on the front and one window on each side of the building. A contactor and photocell shall be provided in the shelter to control the yard lights, which shall be powered from the station house AC panel. Yard lights shall also be controlled remotely through SCADA and be wired to a SEL-2100. All wiring shall be run neatly and correctly in appropriate trade size metallic conduit with necessary fittings and hangers for proper support and routing. The shelter shall include an appropriately sized HVAC package system for heating and cooling and humidity control inside the shelter. HVAC system shall provide sufficient ventilation to meet the requirements for the ventilation of the batteries. All exterior penetrations shall be sealed with a permanent sealant to prevent water, insect, and rodent entry into the shelter. The shelter manufacturer shall provide foundation anchor requirements on the drawings to the Contractor as part of the submittal package. The shelter vent shall have a vent fan including intake, daily timer and hydrogen monitor over ride. The building shall include a smoke detector and building H/L temperature monitor. All alarms in the control house (smoke, door, etc.) shall be of same voltage. The alarms shall be wired to the SEL-2100 logic processor. Interior 24 inch cable tray shall be provided to run cables to all equipment as shown.

2.11 SCADA INTERFACE

A. SCADA shall be furnished under this contract. SCADA shall be compatible with SCADA furnished by Survalent Technology. A communications interface shall be furnished at the control house of the substation. An Ethernet radio, Free-Wave Ethernet 90MHZ radio, with 14 db Yagi antenna, surge arresters, power supplies with battery backup shall be provided in the control house and shall be connected to the SEL-2725 Ethernet switch. SCADA shall consist of communications interface at the substation, HMI at Building 5414, and alarm and data logging. SCADA shall report all required analog and digital data available at the Control House SEL communication processor. Provide alarm reporting for all alarms identified by the communication processors. Provide all digital outputs identified by the communication processor.

2.12 MAIN CONTROL SWITCHBOARD

A. All control and relays shall be Schweitzer Engineering Laboratories (SEL). The panel layout shall be similar to what is shown on the drawings and shall have mimic bus installed as shown. Relays shall be installed on the face of the panel in a layout similar to the drawing. All SEL devices external to the control house shall communicate by weatherproof fiber optic cable. Eight hard bound instruction manuals and three CD copies of the manual are to be provided for each type of relay. The following relays and controls shall be provided:

1. 46 KV MOG’S: Relays shall be SEL-0351S7X3C3E5421 & SEL-2505314XX modules. Quantity of 6 required for SEL-351S7 and quantity of 6 required for 2505 module. Relays shall be programmed with settings from the required coordination study including negative sequence settings and programmed for the control

schematic outlined in the SEL-7000 package. Also included shall be trip coil failure (trip coil # 1 and trip coil #2), breaker failure per SEL's standard, etc. Each 351S shall be supplied with a SEL-9220 (232 to fiber converter).

2. 12.47 KV Main Breakers: Relays shall be SEL-0351S7X3D3E5461. Quantity of 2 required. Relays shall be programmed with setting from the required coordination study including negative sequence setting and also for control scheme outlined in the SEL-7000 package. Fast bus tripping trip, trip coil monitoring and breaker failure are to be implemented. SL 2505 Module breaker alarms to be incorporated into 351S. Each 351S shall be supplied with SEL-9220 (232 to fiber converter).
3. 12.47KV Breakers and Tie Breakers: Relays shall be SEL-0351S7X3D3E5461. Quantity of 7 required. Relays shall be programmed with setting from the required coordination study including negative sequence setting and also for control scheme outlined in the SEL-7000 package. Fast bus tripping trip, trip coil monitoring and breaker failure are to be implemented. SL 2505 Module breaker alarms to be incorporated into 351S. Each 351S shall be supplied with SEL-2886 (232 to 485 converter).
4. Transformer Differential Zone & Metering: Relays shall be SEL-0387613X532X4X1. Quantity of 2 required. Relays shall also supply meter grade information to HMI and SCADA system. Relays shall be programmed for the control scheme outlined in the SEL-7000 package.
5. Transformer Alarms: SEL-2414 Transformer Monitor shall be field installed in the transformer cabinet and required alarms to be wired up to the unit. This module will send its information back to the 3530. The inputs to this device shall include winding temperature, oil temperature and ambient RTD's and multiple transformer alarms. The outputs shall include group 1 and group 2 cooling control, inhibiting control and the cooling lockout. The required fiber optic transceiver shall be SEL-2801MR (in transformer). The associated 2801MT shall be supplied with the SEL-3530. Required fiber shall be SEL-C805G020VVX00XX. A 2812MR is to be supplied with SEL2100 to communicate to the fiber optic port on the 2414 for the Mirror Bit tripping logic.
6. Communications Processor/Station Computer/HMI: This device shall be SEL-33542M1030HXXXXX with SUID# 109F6, SEL-900-0017, SEL-91610013. Relays and other communication device are to exchange data with the unit. This unit shall be set up to provide information to the SCADA system via Ethernet protocol. This device shall be time synced by the SEL-2404 satellite clock. All cabling to connected devices shall send the IRIG time signal.
7. Communication Processor: Communications processors shall be 3530HB0DX211A0. Quantity of 1 required. Communications processor shall have 33 ports and extra I/O. The relays and other SEL devices shall be connected to this communications processor. This 3530 shall send information to the SEL 3355 and communicate information to the DNP SCADA system. All programming and DNP mapping is by Schweitzer Engineering Services. This device shall be time synced by the SEL-2404 satellite clock. All cabling to connected devices shall send the IRIG time signal. The control house alarms shall be wired into the SEL-3530, including battery charger alarms, door entry alarm, building H/L temperature alarms, hydrogen monitor alarm, AC Panelboard surge protection alarm, control house A/C power alarms (2), status & control of yard lighting contactor.
8. Logic Processing: The logic processing shall be performed by the SEL-3530. The fast bus tripping scheme, trip coil monitoring (52A & 52b) & breaker failure shall be utilized for the 46KV switches and 12.47 breakers via SEL-7000 package. This logic shall be set up and tested prior to delivery. Documentation on the description

of operation and how to accurately & completely test this scheme by step by step in the field shall be provided by SEL-7000.

9. IRIG-B Time –Synchronization Source: The time-synchronization source shall be SEL-2404 substation GPS receiver that produces a standard output in either modulated or demodulated IRIG-B format. Part number SEL-24041441X. Also required are the following:

   Three – C953 Cablese in 8ft lengths for connecting the 2404 to the 3354 and 3530.

   One - Gas Tube Coaxial Surge Suppressor: 200-2005

   One – Gas Tube Mounting Bracket: 200 – 2006

   One – C960 RG-6 coaxial cable in 20ft length.

10. I/O: I/O from the battery charger, door alarms, relay failures, hydrogen detector, smoke detector, yard lightning contactor and control, etc. shall be wired to the SEL-3530.
11. Voltage Regulator Controls: The single phase regulator controls shall be SEL-24310X11X1131XXXxxXX. Transceiver required at the communication processor shall be SEL-2810MT. Fiber Optic Cable from 2431to the 3530 processor shall be SEL-C805G020VVX00XX. Quantity of six 2431, six 2801MT (communications processor end) and six C805 are required. The regulator control shall be wired from the I/O on the regulator control to be put into a 1 – Master, 2 – Slave per SEL7000 package requirements.
12. Ethernet Switches: Three 5 port Ethernet switches are to be provided. SEL-2725S22XX. Necessary patch cables to connect 3530, 3355, Ethernet radio are to be provided. A patch cable is to be run over the drop down table for laptop connection into the local Ethernet network.
13. Ethernet Radio: Radio shall be a FreeWave FGR-HTPlus-900RE. Radio is be installed in a lockable enclosure. The enclosure is to include a Pico 125Vdc to 12Vdc converter, surge arrestor and coax jumper. Contractor/Control House provider is to provide the required coax, cabling, surge arrestor, cold shrink kit & antenna. A PCTEL 14 dB yagi antenna is to be mounted on the nearest static pole at least 45’ above ground level. LMR 600 or equivalent coax is required. (Radio & Kit to be supplied by Power Connections, Inc 256.301.9115)
14. Ethernet Security Gateway: An Ethernet security gateway/firewall is required in the HMI panel. SEL-3620X3A3XXX0. This firewall is to be NERC & CIP compliant for cyber security applications. The firewall is to be compliant with +85 C temperature range.
15. Cables: (4) SEL-C663 USB to serial cables are required. (4) C234A Serial Cables (8’) are required.
16. Data Courier: (2) SEL-43910X data couriers are required. (3) USB to SD card reader 240-4050 and paper instruction manuals are required
17. Meter: SEL- 734 Advanced Metering System to be provided on each of the two 12KV main breaker.
18. Fabrication and Finish:

    a. Panels shall be new and constructed of single sheet 11 gauge rolled steel, with all front and back edges formed in a 4 inches radius.

b. Sufficient bracing and reinforcing shall be provided so that the front and side panels shall be self-supporting.
c. Finish: The finish shall be provided with electrostatic paint process – power coat process.
d. One pint of final finish touch up paint shall be included.
e. HML/Communication panel shall be built for rack mountable relays and monitors.

19. Cables, Conductors, Test Plugs, Terminal Strips & Wiring:

a. One - twenty (20) foot SEL cable No. C234A shall be supplied for the customer.
b. Cabling for satellite clock coax and exterior antenna shall be planned for and installed once on site.
c. Plastic raceways shall be used for vertical runs of control wiring.
d. Terminal connectors shall be solder-less ring-tongue terminals.
e. All conductors shall be labeled with opposite termination designations at both ends via slide on label.
f. A 120VAC convenient receptacle outlet, light switch and lamp shall be provided in each panel compartment.
g. A 6 outlet plug strip is to be installed at the base of every other panel for access to 120VAC.
h. Spare terminal strips shall be supplied and installed. Fifteen percent of the total required terminal points shall remain as spare.
i. Required number of SEL cable No. C273A/C272A cables for connecting the relays to communication processors which are inside the control building. Transceivers and fiber optic cables are to be used for all communication connectivity outside the control house.
j. SCADA Ethernet radio is to be installed in control house and coax, cabling, antenna, etc. are to be mounted on side of the building. 10db yagi antenna is to be mounted above the roof of the control house. LMR 400 Coax and surge suppressor are required.

20. Testing Requirements for Panel Builder: Complete circuitry tests on all installed wiring shall be conducted in accordance with the latest application rules of NEMA standard SG5 Production Tests, ANSI C-37.90. These tests shall include, but are not limited to the following:

a. Point to point continuity checks and verifications with the wiring diagrams.
b. Energizing panel with AC & DC f or verifying panel polarity of respective source.
c. Functional testing from terminal block where voltage currents are applied and read out on the relays to show the relays reading the correct voltages and currents.
d. Pulse each input and each output of each relay to confirm it works as specified in the wiring diagrams down to the terminal blocks.
e. Load settings into each relay prior to leaving the factory in 5010 or AcSELerator format.
f. Test reports detailing each input/output per relay tested to the terminal strip with date and time.

21. Mimic Board/HMI Information: Information from the substation and control shall be done via a HMI (Human-Machine Interface). The HMI panel shall be installed at the end of panels closest the exterior door. The HMI shall provide control over the operating functions contained within the Drop-In-Control House. The HMI shall consist of a SEL-3351 computing platform with an SEL touch screen monitor, keyboard and mouse. The HMI shall provide a user interface with all functionality of this control equipment located within the control house. The HMI shall continuously monitor connected equipment and provide automated event logging alarm notifications, and communications functions. The HMI setup and screen shall be SEL-7000. All communications between communication, communications/programming between communication processors, HMI, etc. shall be included in the SEL-7000 package.
22. Time Synchronization Authority: All station IEDs shall be time synchronized with an accuracy of 5 ms.
23. Fiber-Optic Transceivers: Fiber-Optic Transceivers shall operate on port power and require no configuration. Fiber-Optic transceivers shall also automatically multiplex IRIG-B time synchronization signals on the same fiber-optic cable pair as other communications. SEL2800, 2810, or SEL2812 Transceivers are required. Provide one pair of transceivers for 2800M1, 2810MR/MT & 2812MR/MT.
24. Fiber-Optic Cable: The fiber-optic cable shall be hard-card silica multimode, type SEL 200µ ST cable. The cables shall be connected to transceivers using a connector system, type ST that allows field termination without the need for polishing, epoxies, or field testing using an OTDR or other test equipment. The fiber-optic cable shall be available in a PVC jacketed style for conduit installations or a zip-cord style for use in open wire-ways and control panels. Waterproof fiber jacketing is required for fiber outdoors. A T800 V-pin Cable Termination Kit & (4) SEL-915900067 V-pin connector 25 packs are to be provided by the panel builder. The general contractor is to provide the correct amount of fiber optic cable for the job.
25. Spare Parts: The following spare parts are required on this project:

    1 – SEL-0351S7X3C3E5421
    1 – SEL-2725S22XX
    1 – SEL-0387613X532X4X1
    1- SEL-900-0017
    1 – SEL-91610013
    1 – SEL-33235X7X84H04EGF00
    1 – SEL-24310X11X1131XXX31XX
    1 – SEL-915900098 SEL Blue Touch-up Paint
    1 – SEL-915900067 V-pin Connector 25 pack
    1 - SEL-2100XA3443

    All spare relays are to come with hard bound paper manuals and CDs.

2.13 STATION BATTERY INSTALLATION

A. The station battery installation shall include a battery, battery racks, a battery charger, and protective equipment. The station battery installation shall be housed in the station control house.

B. Battery: The battery shall consist of the required number of nickel-cadmium cells interconnected with proper connectors provided by the battery manufacturer to provide a nominal battery rating of 125 volts. Elements of each cell shall be enclosed in a sealed plastic container. Rubber or plastic numerals, of at least 1 inch in height, shall be provided by the battery manufacturer for field attachment to permit proper cell identification. The battery shall have an ampere -hour capacity equal to at least 125 percent of the station's direct-current requirements including normal continuous loads plus intermittent loads. Normal continuous load capacity shall be adequate for an 8-hour period. Intermittent load capacity shall be adequate so that at least three openings and three closings of each of the station's associated circuit breakers and motor-operated switches can occur in an 8-hour period with no more than three circuit breaker or switch units simultaneously operating. Battery circuits shall be ungrounded.

C. Battery Racks: Battery racks shall have welded steel frames and rails finished with two coats of paint of a color matching the battery charger enclosure. Racks shall be no more than two tiers high and top tiers shall be low enough to permit maintenance to be done by personnel standing at floor level. Rails shall have a top covering of plastic or rubber at least 1/16-inch thick. Paint, rubber, and plastic shall resist corrosion and action of the electrolyte. The installation shall be provided with a portable hydrometer syringe and thermometer. Where recommended by the manufacturer, the installation shall include a cell lifter.

D. Battery Charger: The battery charger shall be a constant voltage filtered, voltage-regulated, fully automatic type rated for full-float charging of the associated battery. The battery -charger shall be convection cooled and suitable for operation on electric power supplied from the associated low-voltage alternating-current panel board, shall have adequate capacity to fully recharge the associated depleted battery in not more than 8 hours while supplying normal direct-current loads, and shall have an efficiency of not less than 90 percent. The battery -charger shall have input and output circuit breakers which automatically disconnect the battery -charger when faults occur. The battery -charger shall have an output ammeter and voltmeter and equalizing-float selector switch, and an equalizing timer with a range 0 to 24 hours. The battery charger enclosure shall be painted as specified for indoor cabinets in paragraph "MATERIALS" and "COMPONENTS" and shall be provided with wall mounting brackets or shall be freestanding as required by its size and weight. A relay for sensing loss of alternating-current input, and an adjustable relay for sensing that the battery -charger output voltage has fallen to a pre -set level, shall be installed on the battery-charger to actuate the associated annunciator circuits for the supervisory control interface panel.

E. Protective Equipment: Protective equipment required by IEEE Std. 484 shall be provided and installed in a freestanding cabinet mounted where indicated or directed. The cabinet shall conform to paragraph "MISCELLANEOUS REQUIREMENTS" below. Water facilities required shall be of the portable type consisting of one 5-gallon tank and one 1-quart basin. The tank shall have a removable screw top and a spigot. The basin shall be suitable for rinsing eyes or skin in case of acid spillage.

F. Calculations: Calculations for the battery and associated charger shall be provided and shall indicate the basis used in defining loads, selecting cell types, and determining the battery ampere-hour capacity and physical size. Calculations shall be provided to determine capacity for the battery charger and be similar to those shown in the Appendix to IEEE STD 485, including explanatory data. Calculations for the battery -charger shall

demonstrate that the output voltage and current provided are adequate to comply with the preceding requirements.

2.14 MISCELLANEOUS REQUIREMENTS

A. Concrete Pads: Concrete pads shall be constructed for all equipment in accordance with foundation requirements prepared by the contractor to meet or exceed the design recommended by the manufacturer or as indicated or directed. Tops of concrete pads shall be approximately level and shall project approximately 4 inches above finished grade (insulating rock layer), conduits for primary, secondary, and grounding conductors, as required, shall be installed for each pad prior to pouring pads. Clearances to live parts shall be referenced to the top of the pad and shall exceed NESC (ANSI C2) minimum in worst case by six inches.

B. Fencing: The station shall be enclosed by chain -link fence as shown. Fencing shall be grounded in accordance with paragraph "GROUNDING".

C. Surface Treatment: Horizontal spaces between concrete foundations or pads and fences shall be filled to a minimum depth of six inches above compacted base with well-compacted material such as clean coarse gravel or crushed stone sized between ½" to 1- ½". The material is to have a wet resistivity greater than 3,000 ohm-meters.

D. Lamps and Luminaires

1. Lamps, High Intensity-Discharge: Lamps shall be suitable for the burning position and shall be NEMA C78.380 (2007) Designation S50VA -250. Ballasts shall be coordinated to the lamp the ballast supplies, shall be rated for 240-volt alternating-current operation, and shall have a power factor of not less than 90 percent, a crest factor of 2.0 or less, and a voltage range of not less than plus or minus 10 percent. Ballasts shall be suitable for operating at minus 22 degrees F and above.
2. Luminaires: Luminaires shall be provided to adequately illuminate the station for safe passage, and to permit the satisfactory viewing and operation of the station outdoor equipment during night hours. The minimum illumination level shall be 2-footcandles. Calculations shall be submitted in accordance with detail drawings portion of paragraph "SUBMITTALS" to demonstrate the actual lighting intensity to be provided by the installation of luminaires proposed. The quantity, type, and characteristics of the luminaires shall be sufficient to illuminate overhead busses, structures, and switching equipment and all operating cabinets or mechanisms that are furnished for manual operation from ground level. Contract drawings depict the arrangement, quantity, and type of luminaries necessary for proper brightness and distribution characteristics to provide adequate illumination, but such details are not intended to depict luminaries of a particular manufacturer. Luminaires of a similar quantity, design, brightness, and distribution characteristics will be equally acceptable if proposed and are of equal finish and quality. Detail drawings shall be submitted to demonstrate the equivalence. All accessories required shall be completely identified and provided for a complete and proper installation, and shall include controls required to automatically energize the luminaries at dusk, when natural illumination levels fall below approximately 5-footcandles in intensity, and de-energize them at dawn when natural illumination exceeds the same approximate intensity.

E. Duplex Receptacles: Duplex receptacles shall be ivory in color and provided where shown. Receptacles shall be equipped with weatherproof covers and installed in a weatherproof box with gasket. Receptacles shall be of the ground fault circuit interrupter type, or the receptacles and receptacle circuits shall be protected by a ground fault circuit interrupter type of circuit breaker. Unless otherwise shown, receptacles shall conform to the NEMA WD 1 (2010) Configuration 5-20R rated at 125 volts, 20 amperes and shall be the two -pole, three-wire grounding type. Wiring for outdoor receptacle circuits shall be not less than No. 10 AWG in size and suitable for installation in wet locations.

F. Cabinets: Cabinets shall be of galvanized steel, shall be provided with hinged doors, and shall be suitable for indoor or outdoor installation as indicated. Where locations are not indicated, cabinets shall be suitable for outdoor installation. Thickness of metal and outdoor construction shall be in accordance with UL 50. An indoor cabinet exterior shall have one finish coat and an outdoor cabinet exterior shall have two finish coats. The gray finish color of an outdoor cabinet shall be as specified in paragraphs "MATERIALS" and "COMPONENTS" for cabinets, except as otherwise specified. Finish coats shall be applied over a properly prepared substrate. Each cabinet shall be a freestanding type or may be suitably supported by attachment to an enclosure fence or a switchgear interior wall where located adjacent thereto. A concrete pad shall be provided to support any outdoor cabinet whose base extends to within 3 inches of grade level and pads shall extend at least 2 inches below compacted sub-grade.

1. Fire Extinguisher Storage: An outdoor cabinet for housing a Government-furnished, hand-operated, self-expellant, carbon dioxide fire extinguisher of 10 to 15 pounds capacity for Class C fires shall be provided and located as approved. The cabinet shall have a glass cover door and be painted red.

G. Station Wiring: Field installed wiring internal to equipment or between separate items of station equipment shall comply with the requirements of the NFPA 70 (2014), IEEE 525 (2007) and the following requirements:

1. All low voltage and control wiring installed outdoors shall be 600V THWN, in PVC conduit underground and Rigid Galvanized Steel above ground. Solid wiring may be used for convenience outlets, heating elements, and lighting circuits. Otherwise, the minimum class of stranding shall be Class C. Class K stranding shall be used, however, for wiring between items of equipment mounted on swinging panels or doors and items mounted on fixed panels or parts of fixed assemblies. The insulation type for all switching and control equipment shall be the type SIS unless otherwise specified, indicated, or proposed and approved for use. The minimum wire gauge shall be No. 14 AWG, except No. 18 AWG may be used for circuits that use one ampere or less. Circuits rated less than 115 volts ac or 125 volts dc may be wired with wiring rated 300 volts-to-ground. Otherwise, all wiring shall be rated for 600 volts ac and 250 volts DC. Current transformer circuit wiring shall be not less than No. 10 AWG. Wire markers shall be affixed to each end of wires and shall contain wire number or designations shown on contract or detail drawings, or as otherwise approved. Wire numbers shall also be permanently marked on terminal block marking strips where wires are connected. Tray cable wiring shall have multi-colored wires with overall jacket.

H. Single -Line Electrical Diagram: A single-line electrical diagram of the station shall be furnished. The diagram shall be enclosed between matte-surface thermoplastic sheets

buttoned or otherwise suitably fastened together to allow easy access to the diagram for making any future changes. The enclosed diagram shall be suitable for outdoor mounting and shall be approximately 14 inches by 21 inches unless another size is approved. The diagram shall be attached with temperature - and moisture -resistant, pressure -sensitive adhesive or with other suitable means to an approved location in the metal-clad switchgear enclosure, except when otherwise shown or directed.

I. Danger Signs: One danger sign inscribed in three tiers, "DANGER" "HIGH VOLTAGE INSIDE" "DO NOT ENTER," shall be permanently and securely mounted approximately 5 feet above finished grade on 50 ft intervals on each outward side of the fence enclosure and on each gate. All fasteners used to attach the danger signs shall be stainless steel. Signs shall be of metal and shall have letters of at least 3 inches in height.

2.15 GROUNDING

A. A ground grid system consisting of the indicated configuration of copper wires and ground rods shall be provided to minimize station potential gradient irregularities and shall be installed not less than 3 feet below compacted sub-grade. Equipment, neutral, and surge arrester ground wires shall be connected to the ground grid as indicated.

B. General Requirements: The ground resistance of the station ground system shall be not greater than 5 ohms when measured in normally dry conditions and not less than 48 hours after rainfall.

1. Ground Wires: Ground wires shall be No. 4/0 AWG, unless otherwise shown or specified. After being located to provide maximum physical protection, exposed ground wires shall be securely attached to structural supports at not more than 2-foot intervals with suitable fasteners. Bends greater than 45 degrees in ground wires are not permitted. Routing of ground conductors through concrete should be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit to provide an opening for the ground wire, and the opening shall be sealed with a suitable compound after installation of the ground wire.
2. Ground Rods: Ground rods shall be copper-clad steel 3/4 inch in diameter by 10 feet in length, and shall be driven into the ground until tops of rods are approximately at the elevation of the ground grid. If the minimum ground resistance of 5 ohms or less cannot be obtained with the indicated number of ground rods, additional ground rods, longer ground rods, or deep driven sectional rods shall be installed and connected to the ground grid until the specified resistance or less is obtained, except that the total length of additional ground rods shall not exceed 50 feet. Additional ground rods shall be spaced as evenly as possible and shall be installed a distance of at least 10 feet from any other ground rod.
3. Connections: Connections above grade shall be made with bolted solderless connectors, and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

C. Equipment Grounding: Equipment frames of metal-enclosed equipment, medium-voltage cable terminations, chain -link fencing, metal-structures, and other noncurrent-carrying metal items shall be grounded in accordance with referenced codes by connection to the ground grid. At least two connections shall be provided from a power transformer, a switchgear ground bus, a circuit breaker or fault interrupter switch enclosure, and a grounded iron platform plate to the station ground grid system. Fences shall be grounded at each fixed gatepost, each corner post, and at intermediate posts as indicated on drawings. Each gate section shall be bonded to its gateposts with two 1/8-inch by 1-inch flexible braided copper straps and ground post clamps. Fence ground clamps shall be of the anti-electrolysis type.

D. Neutral Grounding: Neutrals of power transformer shall be solidly grounded as specified in paragraph "POWER TRANSFORMER."

E. Surge Arrester Grounding: A three-phase surge arrester installation shall be grounded by connection to two separate ground rods. Conductors from one ground rod shall be connected to the three-phase surge arrester installation and then to the other ground rod. Both of the ground rods shall be bonded to the station ground grid below grade

PART 3 – EXECUTION

3.1 FACTORY TESTS

A. Factory tests on all manufactured equipment shall be performed in accordance with the applicable publications and with other requirements of these specifications. Factory tests on power transformers shall include the reduced full-wave, chopped-wave, and full-wave impulse test on each line and on the neutral terminal, as listed in IEEE C57.12.00 (2010). Factory tests shall be performed on the breakers and protective devices using a current injection into CT circuit to completely verify proper function on a device-by-device, phase by phase, breaker-by-breaker test. Other functional tests shall be verified by actual operation rather than continuity only. Sequence tests shall be performed using all local devices and simulated remote devices as required. The contractor shall arrange for witness of the factory tests by representatives of the government and shall provide the contracting officer with a 30-day notice of date of testing.

3.2 FIELD TESTS

A. Test procedures and reports for the following tests shall be furnished in compliance with paragraph "SUBMITTALS".

B. Pre-Energization and Operating Tests: Each protective, switching, and control circuit shall be adjusted in accordance with recommendations of the protective device study and tested by actual operation using current injection or equivalent methods as necessary to ensure that every such circuit operates correctly to the satisfaction of the contracting officer. All instrument transformers shall be "flashed" to verify proper polarity. Each protective relay will be demonstrated to operate by injecting current (and/or voltage) at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended. Each switching circuit will be observed to operate the associated equipment being controlled. Each control or signal

circuit will be observed to perform its proper control function or produce a correct signal output. All metering circuits will be verified to operate correctly from potential and current sources similarly to protective relay circuits. Complete ACCEPTANCE TESTS, in accordance with the International Electrical Testing Association (NETA) publication ATS-1999, shall be performed, after the station installation is completed, on all assemblies, equipment, conductors, and all control and protective systems as applicable to verify the integrity of all the systems per paragraph 1.5.B, Inspection, Adjustment and Tests. All relays and metering which uses phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences which may be at a later date than Pre-energization tests, depending on base operational requirements. Tests shall be sequenced and scheduled in accordance with Section 01 07 00, “Contractor Quality Assurance/Quality Control. Testing shall be done by a NETA certified testing organization using appropriate test equipment and performed under the supervision of a registered engineer.

1. Ground Resistance Measurements: The Contractor shall measure the resistance to ground and the resistance of the soil in ohm-centimeters. These values, the soil conditions at the time measurements were made, and the location of each ground rod shall be included in the field test data required in paragraph "SUBMITTALS”. The resistance to ground shall be measured using the fall-of-potential method described in IEEE 81 (2012). The resistivity of the top rock layer shall be measured using the 4 point (variation of depth) method of testing described in IEEE 81 (2012).
2. Pre-Energization Tests: Pre-energization tests shall include, but shall not be limited to, tests that the equipment engineer is required to perform under paragraph "GENERAL REQUIREMENTS.” No part of the electrical system shall be energized until all station grounding system components have been tested and demonstrated to comply with the requirements specified, and the associated test reports have been submitted and approved.

C. Operating Tests: After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. The tests shall be performed in the presence of the Contracting Officer. The Contractor shall furnish the necessary instruments and personnel required for the tests, and the Government will furnish the necessary electrical power.

1.3 QUALITY CONTROL

A. The Contractor shall establish and maintain quality control for operations under this section to assure compliance with contract requirements and maintain records of his quality control for materials, equipment, and construction operations. See SPECIAL CLAUSE entitled "CONTRACTOR QUALITY CONTROL.”

END OF SECTION 26 11 13

SECTION 26 12 19 - PAD-MOUNTED TRANSFORMER

PART 1- GENERAL

1.1 SUMMARY

A. This section of the specification applies to supply and installation of a 7500KVA pad-mounted, liquid-filled medium voltage transformer as indicated on the drawings and specification herein.

1.2 REFERENCES

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

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

IEEE C57.12.00 (2010)	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
IEEE C57.12.28 (2014)	Pad Mounted equipment Enclosure Integrity.
IEEE C57.12.34 (2009)	Requirement for Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 5MVA and Smaller; High-Voltage, 34.5KV and Below; Low-Voltage, 15KV and Below.
IEEE C57.12.70 (2011)	Standard for Terminal Markings and Connections for Distribution, Power, and Regulating Transformers.
IEEE C57.12.80 (2010)	Terminology for Power and Distribution Transformers.
IEEE C57.12.90 (2009)	Test Code for Liquid- Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers (2010).
IEEE C62.11 (2012)	Metal-Oxide Surge Arresters for AC Power Circuits (>1KV).

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TR1 (2013)	Transformers, Step Voltage Regulators and Reactors.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014)	National Electrical Code

1.3 GENERAL REQUIREMENTS

A. Transformer Nameplate: The transformers shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the transformers inside the low voltage compartment. Nameplates shall indicate percent impedance, voltage, KVA, frequency, number of phases, cooling class, insulation class, temperature rise, the number of gallons and composition of liquid-dielectric, and shall be permanently marked with a statement that the dielectric supplied is non-polychlorinated biphenyl.

1.4 SUBMITTALS

A. The following shall be submitted with the transformer in accordance with Section 01 33 00 and the Schedule of Submittals:

1. Manufacturer's Catalog Data: Manufacturer's catalog data including catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of this specification.
2. Installation Procedures and Drawings: Installation procedures and detail drawings showing physical arrangement, connections, provisions for conduit entrance, access requirements, physical size, foundation and support details, and transformer weight. Drawings shall be drawn to scale and/or dimensioned.
3. Factory Test Reports: Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests as listed in section 2.4.12 of this specification. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications.
4. Field Test Report: Field test report shall be submitted for the field test per section 3.2 of this specification.
5. Certificate of Compliance: Certificate of Compliance of previous tests on similar units under actual conditions shall be submitted for impulse test, temperature rise test, sound test and short circuit test.

PART 2 - PRODUCTS

2.1 STANDARD PRODUCT

A. Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts and components.

2.2 REFERENCES

A. The pad mounted transformers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of National Electrical Manufacturers Association (NEMA) and the Institute of Electrical and Electronic Engineers (IEEE).

2.3 RATINGS

A. The ratings of the transformers shall be as follows:

1. 7500 KVA, OA, Continuous
2. Three phase, 60 Hertz
3. High Voltage Primary, 12470 Delta
4. High Voltage BIL, 95 KV
5. High Voltage Taps, + 2 - 2 ½ % rated high voltage tap
6. Low Voltage, 4160 Wye/2400 Volts
7. Impedance, Standard 6.50% with + 7.5% variation
8. Temperature Rise, 65 deg. C above a 30 deg. C average ambient with a maximum ambient not to exceed 40 deg. C.
9. Coolant, insulating, less-flammable fluid, non-PCB per E.P.A. definition 07/01/79.

2.4 CONSTRUCTION

A. Dielectric Fluid: The insulating fluid shall be UL Classified Less-Flammable, seed oil based, biodegradable, non-synthetic electrical insulating and cooling liquid. The fluid shall not be classified as a hazardous waste by any US Government agency. The fluid shall be Envirotemp FR3 fluid or equal.

B. Temperature Rise: The transformers shall carry its continuous rating with average winding temperature rise by resistance that shall not exceed 65 degrees Celsius rise, based on an average ambient of 30 degrees Celsius over 24 hours with a maximum ambient of 40 degrees Celsius.

C. Sound Level: The transformers shall be designed to meet the sound level standards for liquid filled transformers as defined in NEMA TR1 and of 60 decibels.

D. Transformer Compartment: The transformers shall be compartmental type, self-cooled, tamper resistant and weather protected for mounting on a pad. The unit shall restrict the entry of water into the compartments so as not to impair its operation. There shall be no exposed screws, bolts, or other fastening devices which are externally removable. There shall be no openings through which foreign objects such as sticks, rods, or wires might contact live parts. The transformer shall consist of a transformer tank and full-height, bolt-on-high- and low- voltage cable terminating compartments located side-by-side separated by a rigid metal barrier, with the low-voltage compartment on the right when facing the transformer. Each compartment shall have separate doors designed to provide access to the high-voltage compartment only after the low-voltage door has been opened. There shall be at least one additional fastening device accessible only after the low-voltage door has been opened, which must be removed to open the high-voltage door. Doors shall be mounted flush with the cabinet frame. The low-voltage door shall have a handle-operated, three-point latching mechanism designed to be secured with a single padlock. A penta-head locking bolt shall be incorporated into the low voltage door latching mechanism. Both high-and low-voltage doors shall be incorporated into the low voltage door latching mechanism. Both high-and low-voltage doors shall be equipped with lift-off type stainless steel hinges and door stops to secure them in the open position. The entire enclosure shall meet or exceed IEEE C57.12.28 for pad mounted equipment security and paint requirements.

1. Transformer Compartment Size: Compartments shall be designed for cable entry from below and shall be sized to meet or exceed the minimum dimensions required by IEEE C57.12.34. Compartment sills, doors and covers shall be removable to facilitate cable pulling and installation. The high-voltage door shall be on the left and the low-voltage door on the right.
2. Transformer Main Tank: The transformers shall be supplied with a bolted main tank cover and shall be of a sealed-tank construction designed to withstand a pressure of 7 psig without permanent distortion. The tank cover shall be domed to shed water and shall be supplied with a tamper-resistant access hand-hole sized to allow access to internal bushing and switch connections. The transformer shall remain effectively sealed for a top-oil temperature of minus 5 degrees Celsius to 105 degrees Celsius. When necessary to meet the temperature rise rating specified, flat cooling panels of the common header type shall be provided. Lifting, jacking and rolling provisions in accordance with IEEE Standards shall be provided. Stainless steel ground connection pads shall be provided in both the high-and low voltage compartments with (2) ½ -13 UNC tapped holes ½ inch deep.

E. Transformer Windings: The transformers shall be three-phase, 12470 delta connected primary, 95 KV BIL, with a 4160 wye/2400 Volt connected secondary, constructed with two separate windings per phase.

F. Transformer Taps: Full-capacity taps, two steps at 2 ½ percent above and two steps at 2 ½ percent below the rated primary voltage, shall be provided with a tap changing mechanism internal to the main tank. The operating handle for the primary tap changer shall be located within the high-voltage compartment external to the transformer tank, and shall be for de-energized operation.

G Transformer Core: The core material shall be high-grade, grain-oriented, non-aging silicon core steel with high magnetic permeability, low hysteresis and low eddy current losses. Magnetic flux densities shall be kept below saturation to allow for a minimum of 10 percent overvoltage excitation. The core shall be properly annealed to reduce stresses induced during the manufacturing processes and to reduce core losses. The core frame shall be designed to provide maximum support of the core and coil assembly. The core frame shall be welded and bolted to ensure maximum short-circuit strength in accordance with IEEE C57.12.90 requirements. The core and coil assembly shall be baked in an oven prior to tanking to thermoset resins and adhesives in the conductor coatings and inter-layered winding paper and to remove moisture from the insulation prior to vacuum filling with mineral oil.

H. High Voltage Switching and Protective Equipment: Provide a load break, gang operated, liquid immersed switch that is externally operable from the high voltage compartment through the use of a distribution hot-stick. The switch shall be 4-position type for use on a loop feed system. The switch shall be rated for 400 amps continuous and load interrupting rating.

1. Provide Bay-O-Net type oil immersed fuses that are externally replaceable with a hot-stick without opening the transformer tank.
2. Provide dead front 9 KV metal oxide varistor elbow (M.O.V.E) arresters, which are completely shielded and sealed in fully insulated elbows.

I. High-Voltage Terminations and Equipment: The high voltage terminations and

equipment shall be dead front, arranged for loop feed, and shall conform to IEEE C57.12.34 requirements. Six, one piece 600 Amp, 15KV load-break apparatus bushings, meeting the requirements of IEEE Standard 386 for Separable Insulated Connector Systems, shall be provided for use with 600 Amp, 15KV load-break connectors. Dead-front 9KV metal oxide varistor elbow (M.O.V.E) arresters, which are completely shielded and sealed in fully insulated elbows, shall be provided for installation on one set of the 600 Amp loadbreak bushings. Parking stands for mounting accessory equipment shall be provided. Bushings shall be externally clamped to the transformer tank.

J. Low Voltage Terminations and Equipment: The low voltage bushings shall be of dead-front application. The required neutral shall have a porcelain Xo bushing. The low voltage neutral shall be a fully insulated bushing grounded to the transformer tank by a removable grounding strap. Bushings shall be supplied with a threaded support bracket hole on the end of the external spade. Support brackets shall be provided inside the low-voltage compartment for support of the low voltage bushings and secondary cables.

K. Accessories: The following accessories shall be provided:

1. Nameplate in the low voltage compartment.
2. One-inch drain valve with sampling device.
3. One-inch upper filter press and filling plug.
4. Dial type thermometer.
5. Liquid level gauge.
6. Pressure relief valve.

L. Factory Testing: The transformers shall pass the following standard factory tests made in accordance with the IEEE C57.12.90 and NEMA Standards, latest revisions:

1. Resistance measurements of all windings on the rated voltage connection and at the tap extremes.
2. Ratio tests on the rated voltage connection and on all tap connections.
3. Polarity and phase-relation tests on the rated voltage connections.
4. No-load loss at rated voltage on the rated voltage connection.
5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated current on the rated voltage connection.
7. Applied potential test.
8. Induced potential test.
9. Tank leak test.
10. A certified factory test report shall be submitted in accordance with section 1.4. of this specification.

PART 3.0 - EXECUTION

3.1 INSTALLATION

A. The transformer shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed

products. Any modification of installation requirements as shown on the contract drawings to accommodate equal product must be approved prior to installation. The additional cost, if any, to accommodate such modification shall be borne by the contractor.

B. Install transformers on concrete pads as shown on the drawings and specified herein. Connect transformer neutral to the grounding electrode system. The grounding electrode system shall comprise four ground rods at four corners of the transformer pad and 4/0 AWG bare ground conductors connecting them installed underground at least 36 inches below grade level.

3.2 FIELD TESTING

A. Insulation Resistance Tests: Transformer winding insulation-resistance shall be tested using 5000V DC for high voltage winding and 2500V DC for the low voltage winding. Test voltage shall be applied for not less than 10 minutes and until three equal consecutive readings, 1 minute apart are obtained. Readings shall be recorded every 30 seconds during the first 2 minutes and every minute thereafter. Minimum acceptable resistance shall be 5000 megohms for high voltage winding and 1000 megohms for the low voltage winding.

3.3 ACCEPTANCE

A. Final acceptance shall depend upon the successful performance of the equipment under test. Transformers shall not be energized until recorded test data have been approved by the Contracting Officer.

END OF SECTION 26 12 19

SECTION 26 24 13 - LOW VOLTAGE SWITCHBOARD

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section of the specification applies to supply and installation of the additional new switchboard sections to the existing 2000A, 480Y/277V switchboard as indicated on the one line drawing and specified herein. The new additional sections shall include the 2000A main breaker, 2000A tie breaker, and the following feeder breakers:

Two – 400A, 3P breakers
Two – 225A, 3P breakers
Two – 100A, 3P breakers.

1.3 REFERENCES

A. The publications listed below form a part of this specification. The publications are referred to in the test for basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA PB-2 (2011)	Dead-front Distribution Switchboards.

UNDERWRITERS LABORATORIES (UL)

UL 891 (2005)	UL Standard for Safety Dead-front Switchboard.
UL 1066 (2012)	UL Standard for Low Voltage AC and DC power circuit breakers used in enclosures

THE INTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

IEEE C37.13 (2008)	Low Voltage AC power circuit breakers used in enclosures
IEEE C37.16 (2009)	Preferred ratings, related requirements and application for low voltage power circuit breakers and AC power circuit protectors.
IEEE 37.17 (2012)	Trip devices for AC and general purpose DC low voltage power circuit breakers.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2014) National Electrical Code.

1.4 SUBMITTALS

A. The following shall be submitted with the switchboards:

1 Shop Drawings
2 Dimensional plan, elevation and weight of the switchboard.
3 Construction details of the enclosures.
4 Bussing diagrams including bus sizes and current carrying capacities.
5 Complete diagrams of all control and power connections

B. Manufacturer's Catalog Data

1. Insulated case circuit breaker
2. Electronic trip unit
3. Transient Voltage Surge Suppressor
4. Digital meter
5. Instrument transformer
6. Control power transformer
7. Automatic transfer switch

C. Factory Test Report: Certified test report of the switchboard for the factory tests as indicated in article 2.11 of this specification including other routine factory tests of the manufacturer shall be submitted.

D. Field Test Report

1 Insulation Resistance Test
2 Site Acceptance Test

E. Certificates: Certificate of compliance shall be submitted showing evidence of test conducted on similar equipment, proving successful passing of withstand tests of 65 KA main bus specified.

F. Manufacturer's Instructions

G. Operation and Maintenance Data

H. Closeout Submittals

PART 2 - PRODUCTS

2.1 GENERAL

A. The new switchboard sections shall be installed next to the existing switchboard and shall be connected to the existing switchboard through a tie breaker as shown on the one line diagram. The new switchboard sections shall be front-connected, rear-accessible type, front and rear aligned, matching with the existing switchboard. The main and tie breakers shall be draw-type, the branch breakers shall be panel mounted, individually compartmented.

B. The switchboard shall be NEMA 1 indoor construction, free-standing, sectional, dead front low voltage distribution type.

C. The switchboard and all components shall be designed, manufactured and tested in accordance with the latest UL 891 and NEMA PB2 applicable standards.

D. The switchboard shall be accessible from front and rear. Metering and protective devices shall be as indicated on the drawings and specified herein.

E. The switchboard shall be designed for 3-phase, 4-wire, wye-connected, grounded neutral service of voltage indicated on the drawing.

F. The switchboard assemblies shall be rated to withstand mechanical forces exerted during short circuit conditions when connected directly to a power source having a fault current of 65,000 amperes symmetrical at rated voltage.

G. The switchboard shall be used as service equipment as shown on the drawing.

2.2 CONSTRUCTION

A. The switchboard assembly shall consist of the required number of vertical sections bolted together to form rigid assemblies. The design shall incorporate preformed steel channels, angles, and structural components bolted together and reinforced to form a rigid, self-supporting assembly. Fabricate enclosure with removable hinged doors with three-point latch and pad-lockable handle to allow access to rear interior of the switchboard.

B. All sections of the switchboards shall be front and rear aligned. The minimum depth for switchboard shall be 80 inches.

C. The switchboard shall be suitable for additional vertical distribution sections in future.

D. Barriers shall be provided to isolate the bus compartment from the rear compartment and bus compartment to front compartment. Barriers shall also be provided to isolate one vertical section from the adjacent sections.

E. Horizontal barriers shall be provided to form individual circuit breaker or metering compartments. Circuit breaker compartments are to be separated from the bus

compartment through a primary disconnect assembly. Each circuit breaker or metering compartment shall be provided with a hinged front door secured with hand-operated pad-lockable rotary latches.

F. Circuit breaker compartments shall include stationary primary contacts disconnects that shall be silver-plated copper at the connection points and of one piece construction.

1 The upper set of disconnects shall be directly bolt to the main bus, and for feeder circuit breakers, the lower set shall extend to the rear cable area and shall be insulated where they pass through the main bus compartment.
2 Primary disconnects shall be sized for the maximum continuous current for the frame size of the circuit breaker which is located in the compartment.
3 Interlocks shall be provided to prevent a circuit breaker element of incorrect frame size or interrupting rating from being inserted into the compartment.
4 Secondary control and communication connections, when required, shall be accessible from the front of the switchboard without exposing any power cable or bussing. The secondary control contacts shall be of the sliding contact design, silver plated and engage the draw-out circuit breaker element in the “connected” or “test”

a. The assembly shall be provided with adequate lifting means.
b. The switchboard shall be suitable for use as service equipment and be labeled in accordance with UL requirements.

2.3 BUS

A. All bus bars shall be silver plated copper. Main horizontal bus bars shall be mounted with all three phases and neutral arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C over a 40°C ambient (outside enclosure). The bus bars shall be full capacity throughout their entire length. Bus isolation barriers shall be arranged to isolate the buses on the either side of the main breaker

B. A full capacity neutral bus shall be provided. A removable test link (solid bar) shall be provided near the main incoming feeder to disconnect the switchboard neutral bus from the grounded service neutral conductor.

C. A copper ground bus (minimum of ¼ x 3 inch) shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

D. A bonding jumper shall be provided between the switchboard neutral to the ground bus as per requirement on NEC, Article 250-28. This bonding connection shall be located on the line side of the removable neutral link, maintaining a service ground to the switchboard frame when the removable test link is removed.

E. All hardware used on conductors shall be high-tensile strength and zinc plated. All bus joints shall be provided with conical spring type washers.

2.4 WIRING AND TERMINATIONS

A. Small wiring, necessary fuse blocks and terminal blocks within the switchboard shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, push-button, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

B. Compression type terminal lugs shall be provided for all line and load terminals suitable for copper cable rated 75°C and sized as indicated on the drawings.

C. Lugs shall be provided in the incoming line section for connection of the main grounding conductors. Additional lugs for connections of other grounding conductors shall be provided as indicated on the drawings.

D. All control wire shall be bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All current transformer secondary leads shall be first connected to conveniently accessible short circuit terminal blocks before connecting to any other device. All groups of control wires leaving the switchboard shall be provided with terminal blocks and suitable numbering strips. Wire markers shall be provided at each end of all control wiring.

2.5 CIRCUIT BREAKERS

A Main and Tie Breakers:

1. The main and tie breakers shall be insulated case, draw-out type, three pole, 100 percent rated with interrupting capacity to meet the available fault current.
2. Circuit breaker element shall have connected, test, and disconnected position indicators, spring charged /discharge indicators, and circuit breaker open or closed and ready to close indicators, visible to the operator with the compartment door closed. It shall be possible to rack the circuit breaker element from the connected to disconnected positions with the compartment door closed. Provide interlocks to prevent racking the circuit breaker unless the breaker is open.
3. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:

    a. Normal Closing Speed: independent of both control and operator
    b. Operation counter
    c. Mechanism operated cell switch operated by circuit breaker mechanism.

B. Feeder Breakers: The feeder breakers shall be molded case, fixed with interrupting capacity to meet available fault currents.

C. Each low voltage circuit breaker shall be equipped with self-powered microprocessor-based trip device to sense overload and short circuit conditions. The device shall measure true RMS current. The tripping system shall consist of sensor at each phase, a release mechanism, and the following features:

1 Field installable and interchangeable so that any trip unit can be used with any

frame size circuit breaker, and can be upgraded for future expansion in functionality, such as communication.

a. Functions: Instantaneous trip, Long and Short -Time pickup levels, Long and Short-Time time adjustments, Ground-fault pick up level, time delay, and I^2t response.

D. The circuit breakers shall be provided with padlocking provisions for installing at least three padlocks on each breaker to prevent movement of the draw-out mechanism.

1. The circuit breakers shall be provided with operating handle integral to the breakers. No external tool will be required to rack the breaker.
2. The circuit breakers shall be provided with field installable shunt trips as indicated on the drawing.

2.6 CONTROL POWER TRANSFORMER

A. The control power transformer supplying 120V control circuits through secondary disconnect devices shall be dry-type with primary and secondary fuses.

B. The control power transformer shall be mounted in the auxiliary compartment as shown.

2.7 METERING DEVICE

A. Provide metering device as shown in the one line diagram. The metering device shall be provided with a microprocessor based, multi-function, high accuracy digital power metering instrumentation module equipped with LCD or LED display. Power meter shall be Siemens # PAC 4200 or equal. The meter shall be housed in a separate compartment in the switchboard, isolated from the live bus. Current, potential and control power transformers as required shall be furnished with the switchboard. Provide isolation circuit breaker for voltage connections and shorting block for current transformer connections.

B. The metering device shall be provided with Modbus communication capability.

2.8 TRANSIENT VOLTAGE SURGE SUPPRESSOR (TVSS)

A. Provide TVSS with suitably rated breaker or fusible disconnect switch at the service entrance section of the switchboard.

B. The maximum continuous operating voltage of the TVSS unit shall not be greater than 115% of the nominal system operating voltage

C. The TVSS unit must have suppression elements between line-neutral (L-N), line-ground (L-G), neutral-ground (N-G). Seven separate modes of protection must be provided.

D. The total surge current per phase (based on 8X20 microsecond waveform) that the unit is capable of surviving shall not be less than 250,000 amps per phase.

E. The TVSS unit shall be UL listed under UL 1449. The maximum UL 1449 suppression

voltage rating measured at the switchboard bus bar shall not exceed 800V (L-N, L-G, G-N) and 1500V (L-L).

F. The TVSS unit shall include a high performance EMI/RFI noise rejection filter. Noise attenuation for electrical line noise shall be 55 dB at 100 kHz using the MIL-STD-220A filter.

G. The TVSS unit shall be provided with a monitoring system. The monitoring system shall include a green/red solid state indicator light for each phase. The absence of green light and the presence of a red light shall indicate which phase(s) has been damaged. Fault detection will activate a flashing trouble light, form C contacts and an audible alarm.

2.9 MIMIC BUS

A. Provide continuous mimic bus applied to the front of the switchboard arranged in single-line diagram format, indicating arrangement of circuit breakers and automatic transfer switch in the power circuit.

2.10 NAMEPLATE

A. Provide identification tag for the switchboard in engraved laminated plastic identification plate (1/4 inch black letters on yellow background) permanently attached on the front at the top section of the switchboard.

B. The switchboard identification tag shall include switchboard designation, amp rating, voltage, phase, wire and the power source as follows:

4473 – SWBD00XX

2000A, 480Y/277V, 3 PH, 4W

FED FROM 1500 KVA TRANSFORMER

C. Each switchboard feeder breaker shall also be provided with engraved laminated plastic identification plates (1/4 inch black letters on yellow background) indicating feeder designation and breaker rating.

Example: 2000A, 3PH, 4W

MAIN FEEDER BREAKER

FOR SWBD00XX

D. The color of laminated plastic identification tags for switchboard and its feeder compartments shall be yellow signifying utility power.

E. Furnish manufacturer’s nameplate for the switchboards indicating manufacturer’s name, manufacturer’s model number, manufacturer’s serial number, voltage, ampere and short circuit rating.

F. Control components mounted within the assembly, such as fuse blocks, relays, push-

buttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on the manufacturer wiring diagrams.

2.11 SWITCHBOARD ACCESSORIES

A. Provide overhead-circuit breaker lifting device, track mounted at top of switchboard, complete with hoist and lifting yokes.

B. Portable test set for testing all functions of circuit breaker, solid-state devices without removal from the switchboard.

2.12 FINISH

A. All exterior and interior steel surfaces of the switchboards shall be properly cleaned and provided with rust-inhibiting phosphate coating. Color and finish of the switchboards shall be ANSI 61 light gray.

2.13 FACTORY TESTING

A. The switchboard shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchboard shall be tested for operation under simulated service conditions to assure accuracy of the wiring and functioning of all equipment. The main circuit shall be given dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute between live parts and ground.

B. The circuit breakers, the automatic transfer switch, the TVSS and the metering device included in switchboard shall be tested at the factory for their proper operation after the complete assembly of the switchboard.

C. A certified factory test report shall be submitted in accordance with article 1.3 of this specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products. Any modification of installation requirements as shown on the contract drawings to accommodate equal product must be approved prior to installation. The additional cost, if any, to accommodate such modification shall be borne by the contractor.

B. Complete assembly shall be electrically and mechanically connected together at the site from coordinated subassemblies shipped in complete sections from the manufacturer. Installation shall be carefully aligned, leveled, and secured to the foundation and shall conform to the manufacturer's recommendations.

C All cables installed in the switchboard shall be neatly placed by feeders with cable ties and supported vertically and horizontally with rigid insulating materials. Maximum length of unsupported cable shall be 18 inches.

1. Connect the switchboard ground bus to the building ground using 4/0 AWG grounding electrode conductor. The size of the ground conductor shall be same as equipment ground conductors.
2. Connect the metering device to the existing facility Utility Control System (UCS).

3.2 FIELD TESTING

A. Insulation Resistance Test: The main bus of the switchboard shall be subjected to insulation resistance test after the installation is complete. The insulation resistance shall be performed with a 1000 volt megger with the main and distribution switches in off position.

B. Site Acceptance Test: The switchboard shall be tested for final acceptance at site to demonstrate proper functioning of the following:

1. Circuit breakers and their trip units
2. Circuit breaker shunt trips
3. Main metering device
4. Automatic transfer switch

The Site Acceptance Test shall be witnessed and approved by the Contracting Officer or his authorized representative.

END OF SECTION 26 24 13

SECTION 31 10 00 – SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing vegetation to remain.
2. Removing vegetation.
3. Clearing and grubbing.
4. Topsoil stripping.
5. Removing above-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place.
7. Disconnecting, capping or sealing, and removing site utilities.

1.3 MATERIALS OWNERSHIP

A. Except for materials indicated to be stockpiled or to remain government's property, cleared materials shall be removed from the site and disposed of per government’s direction.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Government's premises where indicated.

C. Notify NASA Digging Permit Coordinator Oscar Ford (256-544- 6759) for area where Project is located before site clearing. This includes any borrow area to be used.

D. Install and receive approval from the government’s representative for all erosion control devices before any site work is to begin.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: As specified. Obtain approved borrow soil materials on-site as indicated on drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide erosion-control measures to prevent soil erosion and discharge of soil- bearing water runoff or airborne dust to adjacent properties and walkways.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

3.2 VEGETATION PROTECTION

A. Repair or replace vegetation indicated to remain that is damaged by construction operations, in a manner approved by NASA.

3.3 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

B. Do not interrupt utilities serving facilities occupied by NASA or others unless permitted. Arrange to provide temporary utility services.

C. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding 8- inch loose depth, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.7 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials, including trash and debris, and legally dispose of them at the Redstone Arsenal Landfill (within 5 miles of the project site).

END OF SECTION 31 10 00

SECTION 31 20 00 – EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Preparing subgrades.
2. Excavating and backfilling.
3. Drainage course for slabs-on-grade and other surface treatments.

1.3 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.

B. Bedding Course: Layer placed over the excavated subgrade in a trench before laying conduit.

C. Borrow: Satisfactory soil from adjacent on-site area for use as fill or backfill.

D. Drainage Course: Layer or layers supporting slab-on-grade or other surface treatments used to minimize capillary flow of pore water.

E. Excavation: Removal of material encountered above subgrade elevations.

1. Additional Excavation: Excavation below subgrade elevations as directed by Government's Representative. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Government's Representative. Unauthorized excavation, as well as remedial work directed by Government's Representative, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

H. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below drainage course.

I. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

J. Satisfactory Materials

1. In-situ Materials for Foundation Subgrade: Satisfactory materials for natural in-situ soil for subgrade shall be limited to materials classified in ASTM D 2487 as GW, GP, GM, GC, SP, SW, SC, SM, ML, CL, and CH. These materials must also meet the moisture content given below to be considered “satisfactory.”
2. Fill or Backfill: Satisfactory materials for fill or backfill shall be limited to materials classified in ASTM D 2487 as GC, SC, CL, and CH, when the activity coefficient (AC) is less than 1.25. (The AC may be determined by dividing the P.I. by the percent finer than two (2) microns.) These materials must also meet the moisture content given below to be considered “satisfactory.”
3. Satisfactory Materials Moisture Content: All satisfactory materials as defined in the two paragraphs above must also meet the moisture content requirement below in order to be considered “satisfactory.”

    a. The moisture content of the material at the time of compaction shall be no wetter than 3 percentage points above the optimum moisture content and no drier than 1 percentage point below the optimum moisture content as defined by moisture- density relations test (see ASTM D 698).

K. Unsatisfactory Materials

1. In-situ Material for Foundation Subgrade: Unsatisfactory materials for natural in-situ subgrade shall be materials classified in ASTM D 2487 as Pt, OH, OL, and MH.
2. Fill or Backfill: Unsatisfactory materials for fill or backfill shall be materials classified in ASTM D 2487 as PT, OH, OL, ML, MH, GW, GP, GM, SW, SP, SM, and CH when the AC is greater than 1.25.

L. Cohesionless and Cohesive Materials: Cohesionless materials include poorly and well graded gravels (GP and GW) and poorly and well graded sands (SP and SW). Cohesive materials include clayey gravels (GC), clayey sands (SC), and lean clays (CL), fat clays (CH), silts (ML and MH), and organic materials (Pt, OL, and OH). Materials such as gravel-silt mixtures (GM) and silty sands (SM) will be considered cohesionless only when the fines have a plasticity index of 0; otherwise, they will be considered cohesive.

1. When the results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show fairly flat or reverse-shaped moisture-density curves and cohesive soils will show normal moisture-density curves. Very silty soils may exhibit narrow ranges of moisture content within which optimum compaction can be obtained.
2. Cohesive soil materials include clayey or silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture-density relations of compacted cohesive soils, when plotted on graphs, will show normal moisture-density curves.

M. Degree of Compaction: Degree of compaction required is expressed as a percentage

of the maximum density obtained by the test procedure presented in ASTM D 698.

N. Maximum Dry Density: Maximum dry density is the maximum density when the soil is compacted in accordance with ASTM D 698.

O. Optimum Moisture Content: Optimum moisture content is the moisture content corresponding to the maximum dry density obtained by the test procedure presented in ASTM D 698.

P. Suitable Topsoil: Suitable topsoil shall mean friable clay loam surface soil suitable for use in grass planting. It occurs as a thin soil layer covering naturally well-drained land covered by a heavy growth of grass or which has been covered with a heavy growth of grass during the latest growing period before start of construction. In addition, the topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, and other objects larger than 2 inches in any dimension, roots, and other objectionable material.

Q. Unsuitable Topsoil: Unsuitable topsoil shall mean soil material that does not meet the requirements specified above for suitable topsoil.

1.4 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by NASA or others unless permitted in writing by COR and then only after arranging to provide temporary utility services according to requirements indicated.

1.5 SAMPLING AND TESTING

A. Soil Testing and Inspection Services: Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil testing service approved by the Contracting Officer shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials, sampling and test soil materials proposed for use in the work, and field-testing facilities for quality control during construction period.

Tests for Proposed Soil Materials: Soil materials proposed for use in the work shall be tested. The materials shall be approved by the Contracting Officer prior to start of work as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS FOR EACH TEST METHOD
Satisfactory soil materials	Sampling	AASHTO T 2	One for each source of materials to determine conformance to definition of satisfactory soil materials; additional tests whenever there is any apparent change.
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Mechanical analysis of soil	ASTM D 422	
	Atterberg Limits	ASTM D 4318	
	Moisture content of soils	ASTM D 2216	

B. Quality Control Testing During Construction: Soil materials shall be tested during construction as follows:

MATERIAL	REQUIREMENT	TEST METHOD	MATERIAL TESTED AND NO. OF TESTS	RETEST FREQUENCY
Soil material in- place after compaction at the general site compacted with large self-propelled equipment.	Density of soil-in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method	One compaction test for every 5,000 square feet for each 6 inch (loose) lift; additional test whenever there is any change in moisture	1 test per failed test
Soil material in-place after compaction in isolated areas compacted with hand-guided equipment.	Density of soil-in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method	1 compaction test per 6-inch lift	1 test per failed test
Backfill material in-place after compaction in trenches compacted with hand-guided equipment.	Density of soil-in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method	1 compaction test per 50 linear feet per 6-inch lift	1 test per failed test

C. Reports: No soil material shall be used until a written report of soil test results has been reviewed and approved by the Contracting Officer. Copies of all laboratory test reports shall be submitted to the Contracting Officer within 72 hours of the completion of the test. Copies of all field test reports shall be submitted to the Contracting Officer within 1 hour of the completion of the test. Hand-written field tests are acceptable.

D. Evaluation of Test Results: Soil materials of any classification shall not have a moisture content at the time of compaction that would be classified as unsatisfactory soil materials in the paragraph entitled “Definitions.” Results of density of soil- in- place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if no density test has a value more than 2 percentage points

below the specified density.

1.6 USE OF EXPLOSIVES

A. The use of explosives will not be permitted.

1.7 PROTECTION OF PERSONS AND PROPERTY

A. Excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness. Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage including settlement, lateral movement, undermining, and washout. Topsoil removal operations shall be conducted to ensure safety of persons and to prevent damage to existing structures and utilities, construction in progress, trees and vegetation to remaining standing, and other property.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

C. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 610; with 100 percent passing a 1 inch sieve and 0 to 15 percent passing a No. 50 sieve.

D. Detectable Warning Tape: Polyethylene film warning tape encasing a metallic core, minimum 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, freezing temperatures or frost, and other hazards created by earthwork operations. Provide protective insulating materials as necessary.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Prevent surface water and ground water from entering excavations, from ponding on

prepared subgrades, and from flooding Project site and surrounding area.

D. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

3.2 EXCAVATION

A. Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. Excavate for structures, pavements, and walks to indicate elevations and dimensions. Extend excavations for placing and removing concrete formwork, for installing services and other construction, and for inspections. Trim bottoms to required lines and grades to leave solid base to receive other work.

C. Excavate utility trenches to indicated gradients, lines, depths, and invert elevations of uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit.

1. Excavate trenches deeper than bottom of pipe elevation, 6 inches deeper in rock, 4 inches deeper elsewhere, to allow for bedding course.
2. When personnel may be subject to the hazards of excavation and trenching, precautions as outlined in OSHA Regulations, 29 CFR 1926, shall be adhered to and enforced.

D. Proof roll subgrades, before filling or placing aggregate courses, with heavy pneumatic -tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities.

F. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Government's Representative.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Government's Representative.

G. Stockpile borrow materials and satisfactory soil materials, without intermixing, in shaped, graded, drained, and covered stockpiles. Stockpile soil materials away from edge of excavations and outside drip line of remaining trees.

3.3 BACKFILLS AND FILLS

A. Utility Trench Backfill: Place, compact, and shape bedding course to provide

continuous support for pipes and conduits over rock and other unyielding bearing surfaces and to fill unauthorized excavations.

1. Place and compact initial backfill of satisfactory soil material or subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit. Place and compact final backfill of satisfactory soil material to final subgrade. PVC pipe trenches shall be backfilled per details on drawings.
2. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

B. Fill: Place and compact fill material in layers to required elevations.

C. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

D. Compaction: Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

E. Compact soil to not less than the following percentages of maximum dry density according to ASTM D 698:

1. Under structures, building slabs, steps, the pad for the electrical substation (approximately 225 feet by 250 feet), and pavements, scarify and re-compact top 12 inches of existing subgrade and each layer of backfill or fill material at 100 percent.
2. Under walkways, scarify and re-compact top 6 inches below subgrade and compact each layer of backfill or fill material at 95 percent.
3. Under lawn or unpaved areas, scarify and re-compact top 6 inches below subgrade and compact each layer of backfill or fill material at 90 percent.

F. Grading: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated. Grade lawns, walks, and unpaved subgrades to tolerances of plus or minus 1 inch and pavements and areas within building lines to plus or minus 1/2 inch.

G. Surface Course Place surface course on prepared drainage course. Compact to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry weight as measured in the field in accordance with ASTM D1556.

H. Under slabs-on-grade, place drainage course on prepared subgrade. Compact to required cross sections and thickness to not less than 95 percent of maximum dry unit weight as measured in the field in accordance with ASTM D1556.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: The Contractor shall engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

B. Allow testing agency to test and inspect subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

3.5 PROTECTION AND DISPOSAL

A. Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

D. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 20 00

SECTION 31 30 00- SOIL INFORMATION

PART 1- GENERAL

1.1 DESCRIPTION

A. The subsurface exploration and geotechnical engineering study of the substation location was performed by OMI, Inc. The copy of the report is attached in the following pages of this section of this specification.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

OMI, Inc.

SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING STUDY
Proposed
46KV Substation
Morris Road and Titan Road
Redstone Arsenal, Huntsville, Alabama

OMI Job No. 6865

April 9, 2014

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5151 Research Drive, N.W., Suite A Huntsville, AL 35805 Tel: (256) 837-7664 Fax: (256) 837-7677 E-mail: omi@omi-eng.com

OMI, Inc.

April 9, 2014

KAYA Associates, Inc.
Building 4241, Room 121D-4
Huntsville, AL 35812

ATTN: Mr. Robert White

SUBJECT: Report of Geotechnical Engineering Study
Proposed 46KV Substation on Morris Road
Marshall Space Flight Center, Alabama
OMI Job No. 6865

Gentlemen:

OMI, Inc., has completed a subsurface exploration and geotechnical engineering study for the referenced project. Enclosed is the report of the findings as well as recommendations for foundation design and construction, site preparation, and other geotechnically related site activities. This work was authorized by Mr. Robert White of KAYA Associates, Inc.

OMI, Inc., appreciates the opportunity to be of service KAYA Associates, Inc. and looks forward to continued involvement with the construction monitoring phase of this project. Please direct any questions concerning this report to the undersigned.

Respectfully submitted,
OMI, Inc.

Christopher A. Harvey, P.E.
Senior Engineer

Distribution: 3 Copies to Addressee

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OMI, Inc.

1.0 EXECUTIVE SUMMARY

This site is suitable for the support of the proposed substation. Development of the site should be relatively straightforward and consist of stripping, removing existing structures, moving utilities and placing fill. Surface remnants of previous development may be encountered on this site. The resistivity testing did not show any evidence of sinkhole activity or propagation on this site. Foundations for the proposed structure are expected to be soil bearing drilled piers. Bearing pressure, lateral resistance, and friction coefficient values have been provided so that the piers may be sized according to the load on each. Specific recommendations for foundation design and site earthwork are given in the body of this report.

2.0 INTRODUCTION

OMI, Inc., has completed a design geotechnical engineering study for the proposed 46KV substation on Morris Road of Marshall Space Flight Center, AL. This report outlines the scope of services provided and presents comments and recommendations based on professional opinions formed during the course of this study. This work was authorized by Mr. Robert White of KAYA Associates, Inc. The work was performed in general accordance with OMI proposal number P-4188A.

Assessment of the environmental aspects of this site, including previous land use or the determination of the presence of any chemical, industrial, or hazardous waste is beyond the scope of this study. However, OMI can provide these services if desired.

3.0 EXPLORATION METHODS

The procedures used by OMI for field and laboratory testing are in general accordance with ASTM procedures and established engineering practice. Brief descriptions of the procedures used in this exploration are contained in the Appendix of this report.

Four soil test borings to 15-ft each were performed during this study near the corners of the proposed substation. Boring locations are shown on the appended Site Plan. A member of the OMI professional staff directed the drilling and logged the soils in the field during testing. Subsequently, each sample was sealed and transported to the office. Selected samples were tested to determine the natural moisture contents of the soil. These tests assist in confirming the visual classifications as well as provide an index of certain engineering properties. The soil classifications, field testing data, and the results of the laboratory tests are provided on the Soil Boring Records in the Appendix of this report.

Electrical resistivity testing for grounding was performed at this site. Taking the measurements involved driving a series of electrical probes into the ground at predetermined spacings along a line. Electrical current was then sent between the probes and the resistivity of the soil was measured. The Wenner method was used to determine electrode spacing for the resistivity testing with a spacing of 10-ft. The resistance was measured along two lines on the site. The graph for each line is appended to this report.

These two lines were also used to conduct 2D resistivity profile lines. A dipole-dipole array with a spacing of 5-ft was used to collect the data. Two profile lines were generated from this data. The results are attached.

OMI also conducted a 3D grid electrical resistivity survey in the area east of the north wing of building 4666. The grid consisted of four parallel lines of 56 probes each running generally north to south 10-ft apart with the probes spaced 5-ft apart. The area of the survey was approximately 30-ft wide by 275-ft long. This is larger than the area of concern but was necessary to get the proper depth for the survey. The location and orientation of the resistivity survey is shown on the attached Site Plan.

Electrical resistivity is a non-destructive, non-intrusive method of studying subsurface soil and rock conditions. It can also identify variations such as voids in the soil or rock such as sinkholes, caves, old filled in trenches, buried debris, or underground storage tanks. The process includes driving a series of electrical probes into the ground at set spacings and along a line or grid. Electrical current

is then pushed between two probes and the resistivity of the soil is measured at intermediate probes. The depth of the area studied increases as the distance between the electrical probes increases. As soil materials change in consistency, which may be a result of mineralogy, moisture content, density, or foreign materials, the electrical resistivity or conductivity changes. Therefore, if a sinkhole, cave, or underground variation is present under the resistivity profile, a change in resistivity will show up due to the changed conditions in the soil profile. The specific method of probe spacings and the distance between probes influences the size and depth to which an object can be identified. Generally, close spacings provide better detail but can only check for shallow features.

A memory earth resistivity meter was utilized for this project to collect field data. During the test, a computer systematically switched between two sets of probes, one set sending current and one set obtaining resistance measurements. The switching continued through a predetermined combination of probe sets to collect the number and relative locations of measurements required for mathematical modeling. A dipole-dipole array was utilized for the collection of the 2D data for this survey. This type of array is typically used to look for fracture zones, voids and sound rock in horizontal bedding planes. A pole-pole array was utilized for the 3D survey. This array was used to increase the depth of the survey.

The field data subsequently was used to create a model of the subsurface conditions beneath the survey area utilizing modeling software. This modeling software produces a graphical contour diagram that displays the apparent resistivities derived by the mathematical model. Each contour interval is colored and represents different apparent resistivities as calculated by the modeling software. The 2D and 3D models are attached.

4.0 SITE CONDITIONS

The site for the proposed substation is located near the southwest corner of Morris Road and Titan Road on Marshall Space Flight Center, AL. The site is located north of building 4475 and south of tank 4444. Topographically the area of the proposed substation is generally flat with gentle slopes directing drainage to the east where it is collected in a drainage ditch. Mowed grass covers the majority of the site area with a concrete sidewalk near the center and an asphalt parking area on the north end.

5.0 SUBSURFACE CONDITIONS

Topsoil was encountered in the upper 6-in across the southern portion of site. Traces of limestone gravel were found in the topsoil likely from previous development. Generally two layers of soil were encountered below the topsoil. The upper layer was dark brownish tan low to medium plastic sandy silty clay while the lower layer was mottled brown tan gray medium to high plastic sandy silty clay. At 8.5-ft on the east side of the site, the soil transitions to a red high plastic sandy silty clay with traces of chert gravel.

Standard penetration test (SPT) values in the upper low to medium plastic layer ranged from 7 to 11 blows per foot (bpf) with an average of 9 bpf. Pocket penetrometer test values ranged from 2.0 to 2.5 tons per square foot (tsf) with an average of around 2.25 tsf. Natural moisture contents in this layer ranged from 20 to 27 percent with an average of 23 percent. This layer ranged in depth from 3.5-ft in borings B-2 and B-4, to 6-ft in borings B-1 and B-3.

The mottled high plastic sandy silty clay had SPT values that ranged from 10 to 21 bpf with an average of 16 bpf. Pocket penetrometer test values ranged from 2.5 to 4.0 tsf with an average of 3.5 tsf. Natural moisture contents in this layer ranged from 19 to 29 percent with an average of 22 percent.

The red sandy silty clay was encountered below the mottled layer in borings B-2 and B-4. Standard penetration values in this layer ranged from 17 to 23 bpf averaging around 20 bpf and pocket penetrometer test values ranged from 3.5 to 4.0 tsf with an average of 3.75 tsf. Natural moisture contents in this stratum ranged from 23 to 29 percent.

Groundwater was not observed during drilling. The borings were filled upon completion due to safety concerns. Therefore, extended water levels were not taken. Because of the geology of this region, the groundwater levels are generally a function of seasonal precipitation and locally heavy rainfall events. Consequently, the groundwater levels can and do fluctuate with time.

6.0 RESISTIVITY RESULTS

6.1 Wenner Grounding Survey

Two resistivity sounding lines were performed on this site for the purpose of grounding. A Wenner array was used to collect the data set at a 10-ft A spacing. Line 1 was located near the center of the proposed substation and oriented west to east. The raw resistivity values ranged from 45.01 Ohm-m to 69.11 Ohm-m. The inverted resistivity values for this line ranged from 20.35 Ohm-m to 157.98 Ohm-m. Line 2 was located along the eastern side of the substation and run in a north to south direction. This line had raw resistivity values ranging from 88.64 to 116.73 Ohm-m and inverted resistivity values ranging from 50.17 to 319.17 Ohm-m. Based on these survey results and the correlation with the soils in the borings, the soils on the western portion of the site have better grounding characteristics and properties. The soils on the western portion of the site appear to have less chert gravel which may help with the installation of grounding rods.

The 1D resistivity models of the two lines are in the appendix of this report along with data tables showing the raw and inverted data.

6.2 2D and 3D Resistivity Survey

OMI performed a 2D dipole-dipole survey at the same locations as the Wenner Grounding survey utilizing the same equipment and cables but increasing to 56 probes. The probe spacing was set at 5-ft. This allowed the survey to model down to a depth of around 65-ft.

The 2D profiles indicated the site is underlain by horizontal clay layers with the bottom of the survey being close to the rock interface. The profiles did not indicate the presence of any major slots or anomalies that would represent karst activity such as sinkholes or caves.

The 3D survey measured 95-ft by 170-ft and was centered on the footprint of the proposed substation. The long axis was oriented in the east west direction due to site constraints. The pole – pole method was used for the grid with probe spacing set in order to model the underlying soil and rock to a depth of around 115-ft.

The model indicated that the soil at the surface on the western side of the site had much lower resistance values than the east. There were two near surface anomalies noted on the models. One was located on the southern edge of the grid at the location of the sidewalk. The other was located near the northeast corner 5-ft to 10-ft below the surface. This anomaly is most likely associated with an underground chilled water line that runs through this area. There appears to be some influence from this line deeper in the ground to the southwest. This could be an indication of a possible leak in the piping system. Based on the model it appears that the top of the underlying bedrock is relatively flat and sound with no evidence of major joints or fissures. The interface appears to range from 65-ft to 75-ft below the surface. There were no indications of sinkholes or voids in the resistivity model.

The 2D resistivity profiles and multiple views of the 3D resistivity model are located in the appendix of this report.

7.0 SITE GEOLOGY

Published geologic information indicates the proposed site is underlain by the Tuscumbia Limestone. The Tuscumbia Limestone formation is of Mississippian age (310-345 million years). In the vicinity of the site, the Tuscumbia limestone is composed of light gray to light brownish-gray, fine to coarse grained, fossiliferous limestone containing chert lenses and nodules. Soils derived from the in-place weathering of the Tuscumbia Limestone are moderately red to reddish-orange clay with variable amounts of chert.

Sinkhole Activity

Sinkholes have occurred in this formation within the vicinity of this site. However, surface observations the subsurface exploration and the resistivity survey did not indicate subsurface voids or active sinkhole propagation on this site.

8.0 PROJECT INFORMATION

OMI understands that an electrical substation at is planned to be constructed near the southwest corner of Morris Road and Titan Road. The substation will be located north of building 4475 and south of building 4444. Based on the site plan provided, the footprint of the proposed substation is 140-ft by 150-ft. Loading information is not available at this time. However based on previous experience with similar structures, loads on the foundations are expected to be less than 50,000 pounds with up to 20,000 pounds of uplift. Lateral loads are expected to be less than 5,000 pounds. The proposed pad elevation is 588.95-ft MSL. Based on this elevation, three to four feet of fill will be required to bring the pad to the desired elevation.

9.0 BASIS FOR RECOMMENDATIONS

The following recommendations are based in part on the preceding project information. This study has utilized the subsurface data, historical information regarding the structural performance of similar structures, and past experience with similar geologic environments to develop professional opinions on which the recommendations are based. Because the structural elements of the design greatly influence the design recommendations, OMI must be provided the opportunity to review the following comments and recommendations in light of changes in location, elevation, or structural loading.

Standard practice in geotechnical engineering is that all but a few special structures will tolerate 1-in of settlement. Therefore, 1-in is assumed acceptable. Unless otherwise stated, the recommendations in this report are intended to keep post-construction settlement to less than 1-in.

10.0 DESIGN RECOMMENDATIONS

10.1 Foundation Design

Provided the site is prepared in accordance with the recommendations contained in this text, the proposed structure may be supported by soil bearing drilled piers bearing on residual soil. Footings should be designed based on a maximum allowable bearing pressure of 2,000 psf; this pressure includes a factor of safety of at least three against general shear failure. Skin friction or the bond between the soil and the concrete of the pier foundation can be used to resist uplift and vertical down loads. The adhesion of the soil to the concrete that is poured directly against the soil can be taken as 500 psf. The top 2-ft of the concrete pier should be ignored because the soil may shrink away from the concrete pier during drier conditions. Further a factor of safety of three should be used for vertical down loads and a safety factor of two should be used for uplift resistance due to wind loads. To allow for minor inconsistencies in the soil subgrade, piers should have a minimum diameter of 24-in, regardless of loading. Foundations should bear at least 2-ft below finished grade to provide adequate confinement and protection against frost and movement due to moisture fluctuations.

Lateral loads applied to the foundation may be resisted by passive resistance against the face of the footing, provided the footings are cast neat against the side of the excavation. The passive resistance can be estimated using an equivalent fluid weight of 130 pcf.

10.2 Seismic Classification

OMI has reviewed the soils at the site with respect to the criteria for seismic classification. In accordance with Section 1613.1, Table 1613.5.2 of the 2006 International Building Code, OMI judges the soil to be Site Class D.

10.3 Fill Soils

Fill soils should be clayey soils free of organics, deleterious debris, or rocks larger than 3-in in diameter. The soil should have a plasticity index (PI) of less than 30 and a maximum dry density of at least 95 pcf as determined by the standard Proctor (ASTM D698). The fill should be compacted to at least 95 percent of the soil's standard Proctor maximum dry density, SPMDD. The top 1-ft beneath the substation pad and pavement areas should be compacted to 100 percent SPMDD.

11.0 CONSTRUCTION CONSIDERATIONS

11.1 Site Preparation

To prepare the site for construction, the construction area should be stripped of grass, topsoil, large root zones, other organic or soft soil, concrete sidewalks, and asphalt. Stripping should extend at least 10-ft beyond the limits of construction cut and fill. Subsequently, the areas approximately at grade or to receive fill should be proofrolled in the presence of a geotechnical engineer. Proofrolling is performed by repeated passes of a heavy rubber-tired vehicle, such as a loaded dump truck. Any areas judged to deflect excessively during proofrolling should be undercut to a stable soil horizon. Such over-excavation must be backfilled with structural fill placed as described below. Upon reaching subgrade elevation in cut areas, the exposed soil subgrade should be similarly proofrolled and repaired.

Remnants of previous development may be encountered at this site. The remnants should be removed if encountered and replaced with compacted soil fill as outlined in this report. Remnants may include but are not limited to foundations, utility trenches and lines, and concrete slabs or debris.

11.2 Estimated Topsoil Removal

The depth of topsoil varies across the site. OMI believes that the stripping depth to remove the topsoil will average about 6-in. Close observation by OMI personnel during construction can allow the disturbed but only slightly organic soils to be compacted in-place or to be used as engineered fill.

11.3 Fill Placement

After proofrolling is complete, placement of structural fill may begin, as necessary. Specific requirements of the soil properties are discussed previously. The soil should be placed in loose lifts, not exceeding 8-in in thickness, and systematically compacted to at least 95 percent of the soil's standard Proctor maximum dry density (ASTM D698) except the top 1-ft should be compacted to 100 percent SPMDD.

11.4 Density Testing

Field density testing should be performed on each lift prior to placement of additional lifts. Test locations should be evenly distributed throughout the fill area and should be performed at the frequencies shown on the following table.

AREA	METHOD OF PLACEMENT AND COMPACTION	INITIAL TEST FREQUENCY	RETEST FREQUENCY
General Site	Large self-propelled equipment	1 test per 5000-ft^2, minimum 3 tests per lift	1 test per failed test
Isolated Areas	Hand-guided equipment	1 test per lift	1 test per failed test
Trench backfill and behind retaining walls	Hand-guided equipment	1 test per 50 linear feet per 6-in of fill	1 test per failed test

Test frequencies may be increased during the early stages of earthwork construction. Compaction requirements should apply to all excavation/backfill operations conducted on the proposed development property.

11.5 Footing Observations

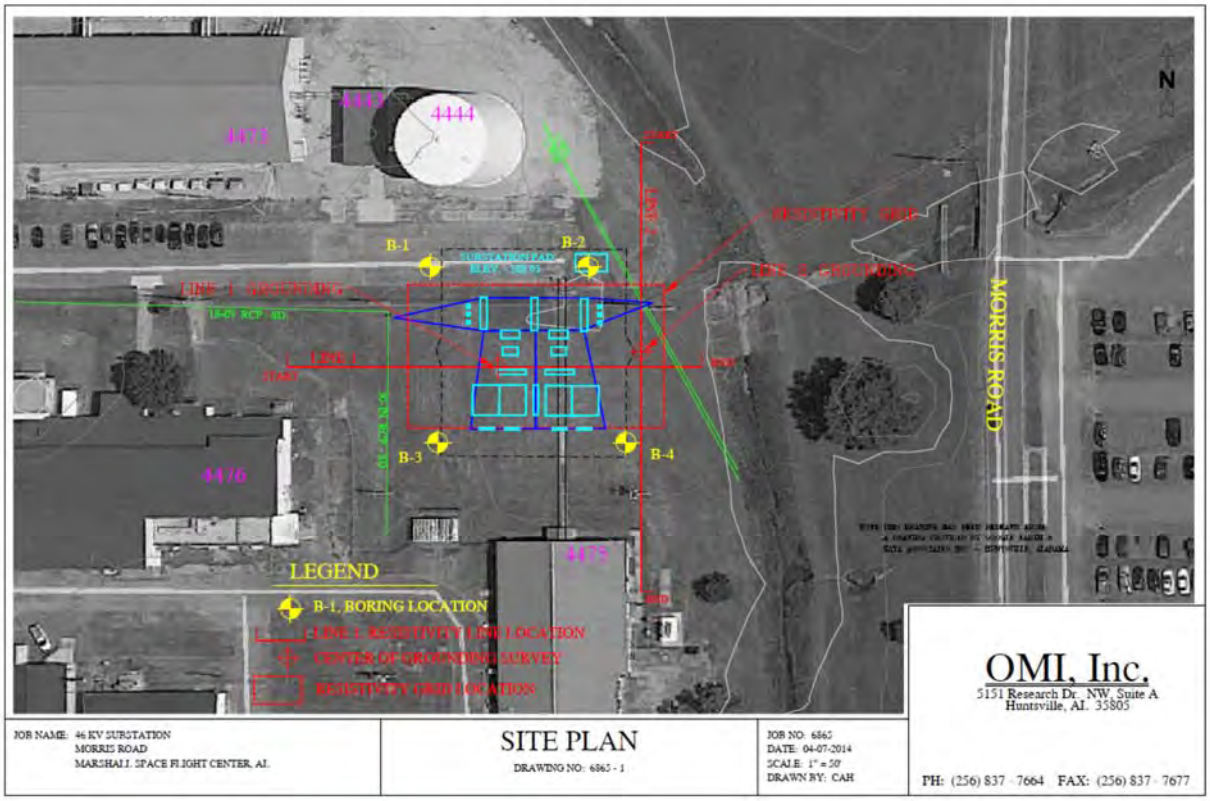
The footing excavation process generates a disturbed layer of soft soil in the excavation bottoms. This soft compressible layer should be removed prior to placement of concrete. Each foundation excavation should be observed by a member of OMI's professional staff to check for local variations in the soil strength as well as the removal of the disturbed layer.

11.6 Construction Monitoring

The foundation and site preparation recommendations contained in this report are based on the conditions encountered during the subsurface exploration and past experience in this geologic setting. Because subsurface conditions may vary from the anticipated, it is important to have a well-rounded quality control program. Construction monitoring on a project of this nature can serve as an economical means to achieve the best possible foundation system and reduce the potential for future problems. The involvement in the subsurface exploration portion of this project uniquely qualifies OMI, Inc., to provide these services as a party responsible to the Owner. OMI, Inc., strongly recommends that all construction monitoring be performed under contract with the Owner or the Owner's representative.

APPENDICES

OMI, Inc.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LEGEND
B-1, BORING LOCATION
LINE 1 RESISTIVITY LINE LOCATION
CENTER OF GROUNDING SURVEY
RESISTIVITY GRID LOCATION
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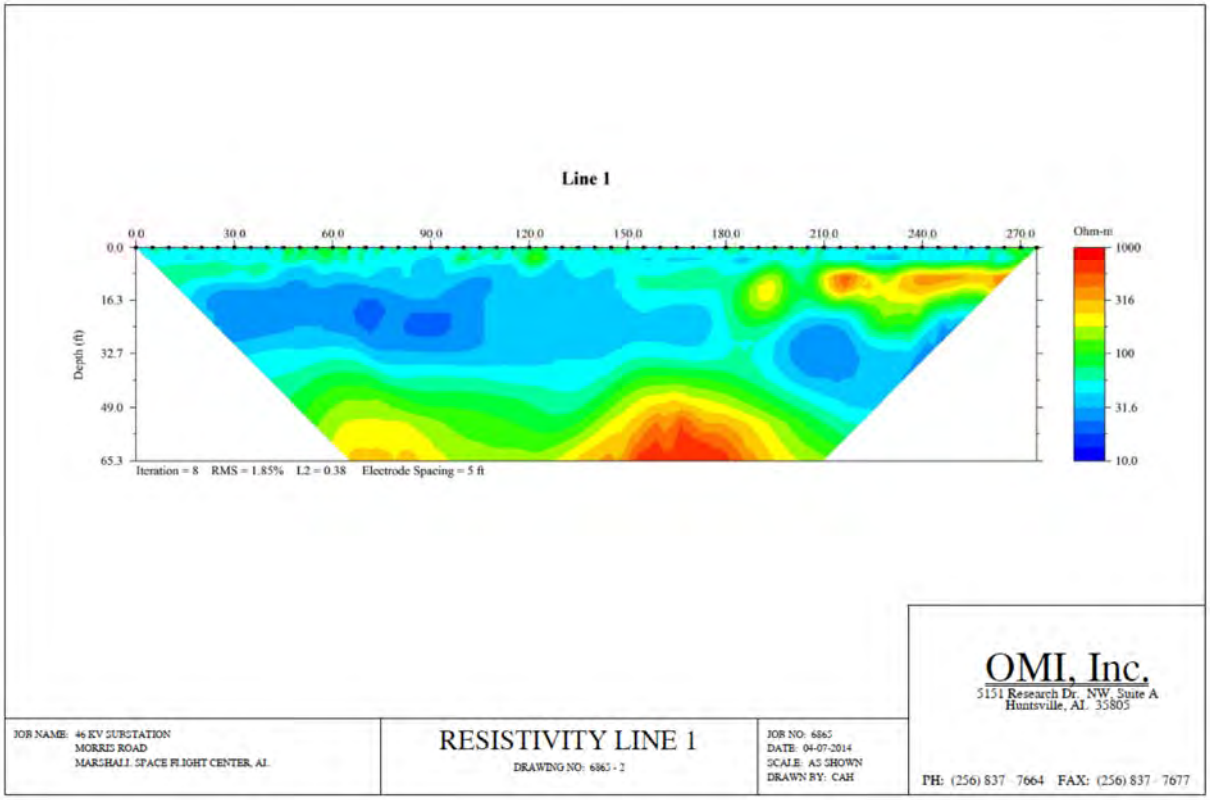
JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL
SITE PLAN
DRAWING NO: 6865 - 1
JOB NO: 6865
DATE: 04-07-2014
SCALE: 1" = 50'
DRAWN BY: CAH
PH: (256) 837 - 7664 FAX: (256) 837 - 7677


Line 1
0.0
30.0
60.0
90.0
120.0
150.0
180.0
210.0
240.0
270.0
Depth (ft)
0.0
16.3
32.7
49.0
65.3
Ohm-m
1000
316
100
31.6
10.0
Iteration = 8 RMS = 1.85% L2 = 0.38 Electrode Spacing = 5 ft
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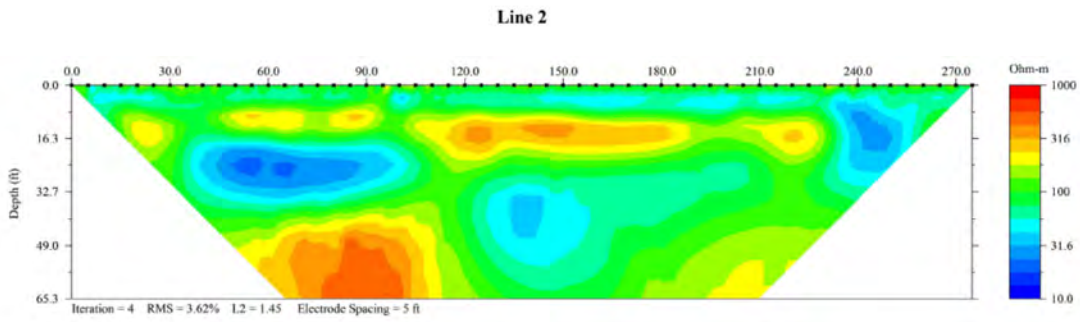
Huntsville, AL 35805
JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL
RESISTIVITY LINE 1
DRAWING NO: 6865 - 2
JOB NO: 6865
DATE: 04-07-2014
SCALE: AS SHOWN
DRAWN BY: CAH
PH: (256) 837 - 7664 FAX: (256) 837 - 7677



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JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL

RESISTIVITY LINE 2
DRAWING NO: 6865 - 3

JOB NO: 6865
DATE: 04-07-2014
SCALE: AS SHOWN
DRAWN BY: CAH

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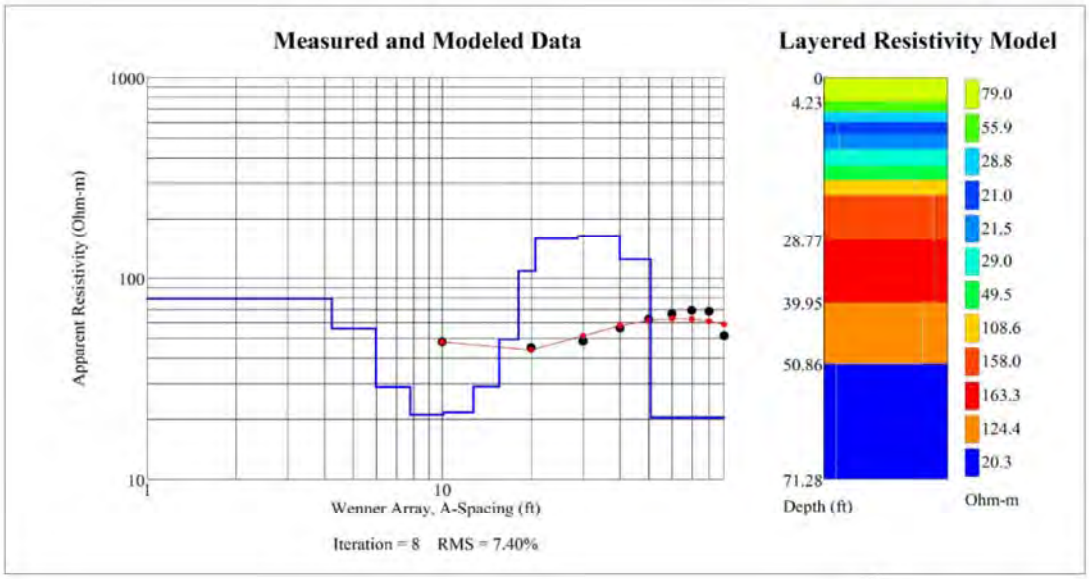

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JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL

RESISTIVITY GROUNDING LINE 1
DRAWING NO: 6865 - 4

JOB NO: 6865
DATE: 04-07-2014
SCALE: AS SHOWN
DRAWN BY: CAH

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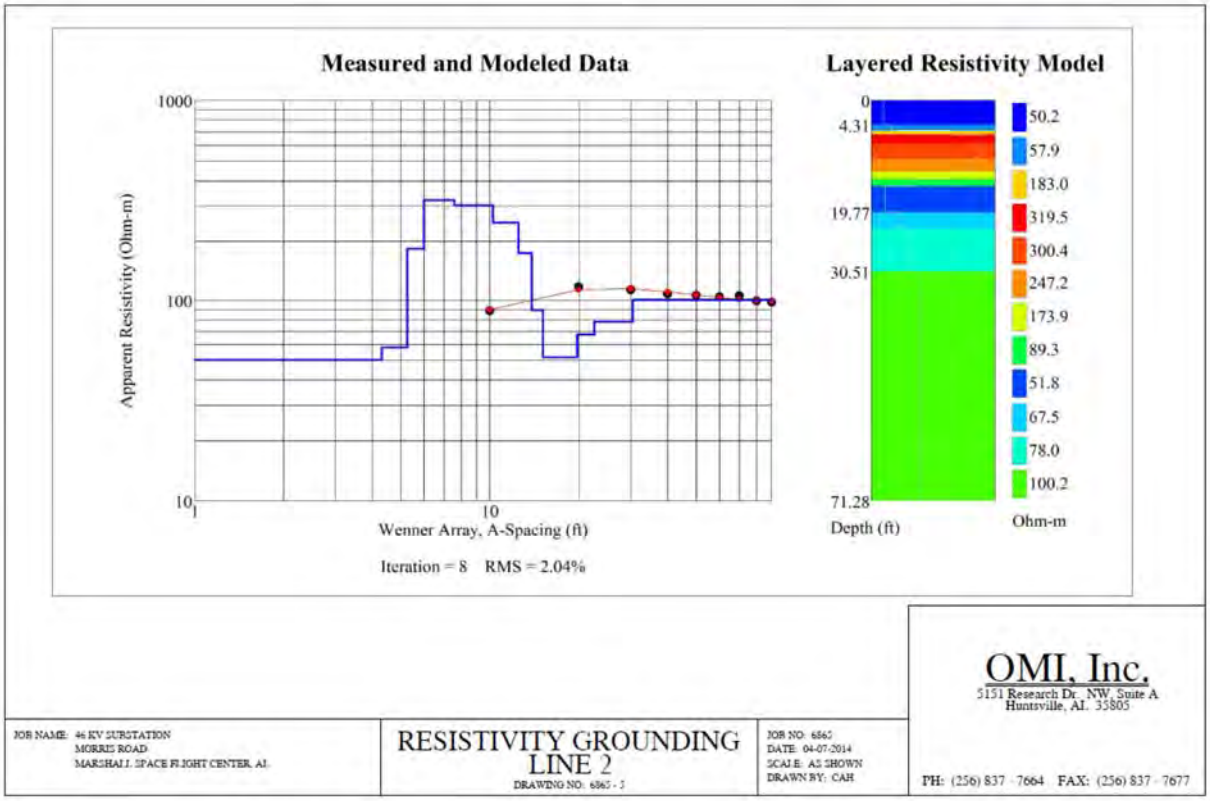
Measured and Modeled Data
Layered Resistivity Model
1000
100
10
1
10
Apparent Resistivity (Ohm-m)
Wenner Array, A-Spacing (ft)
Iteration = 8 RMS = 2.04%
0
4.31
19.77
30.51
71.28
Depth (ft)
50.2
57.9
183.0
319.5
300.4
247.2
173.9
89.3
51.8
67.5
78.0
100.2
Ohm-m
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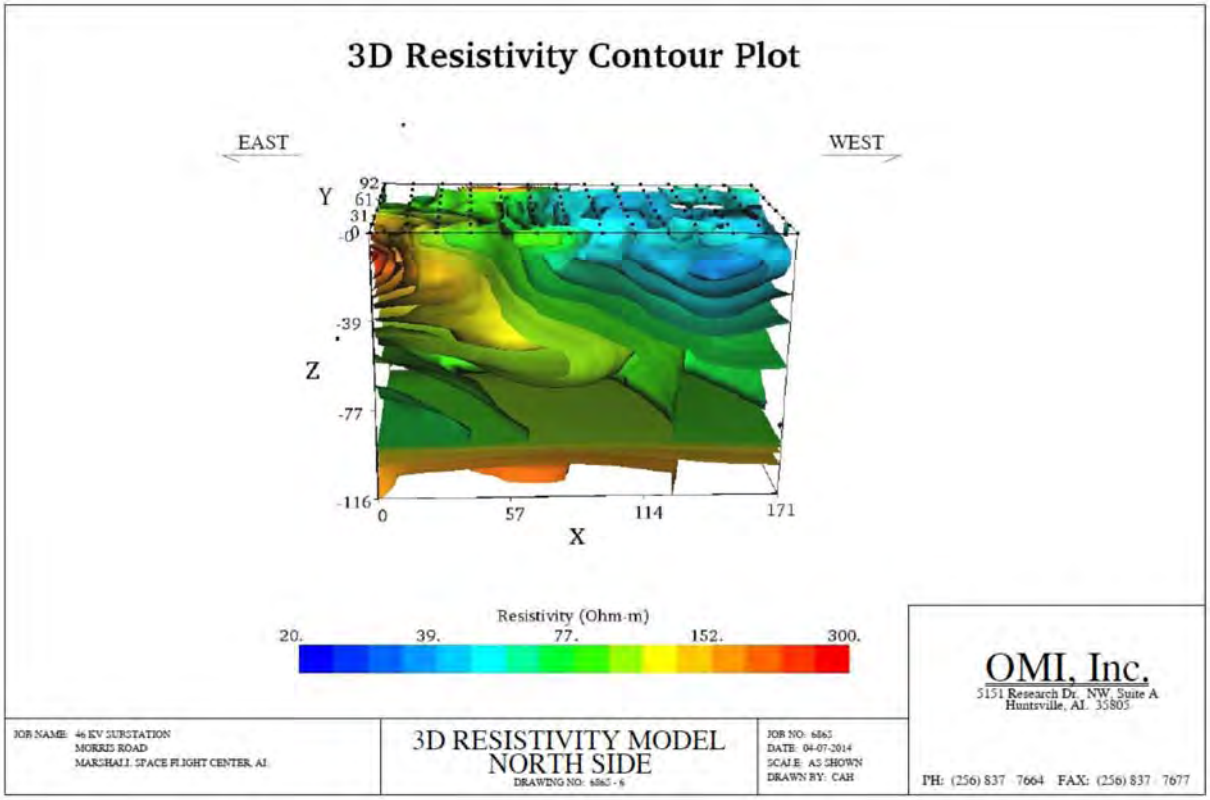
Huntsville, AL 35805
JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL
RESISTIVITY GROUNDING LINE 2
DRAWING NO: 6865 - 3
JOB NO: 6865
DATE: 04-07-2014
SCALE: AS SHOWN
DRAWN BY: CAH
PH: (256) 837 - 7664 FAX: (256) 837 - 7677


3D Resistivity Contour Plot
EAST
WEST
Y
92
61
31
0
-39
Z
-77
-116
0
57
114
171
X
Resistivity (Ohm-m)
20.
39.
77.
152.
300.
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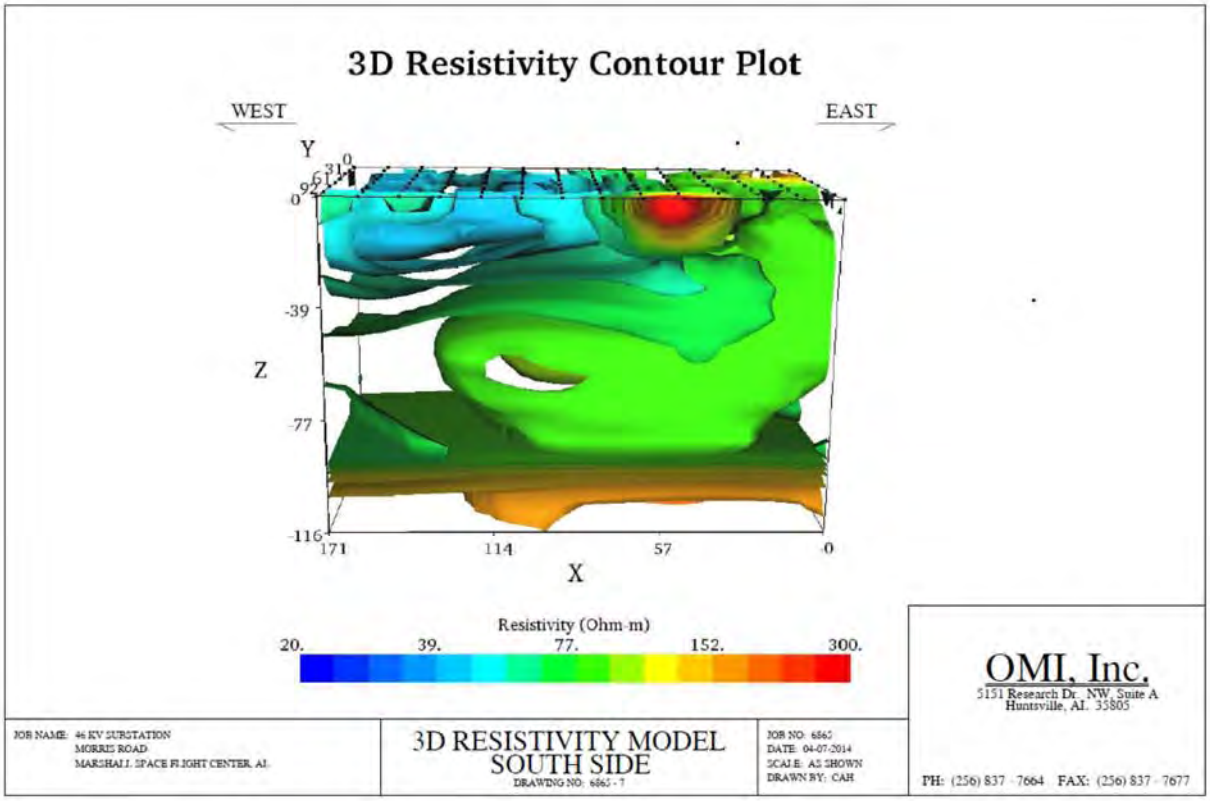
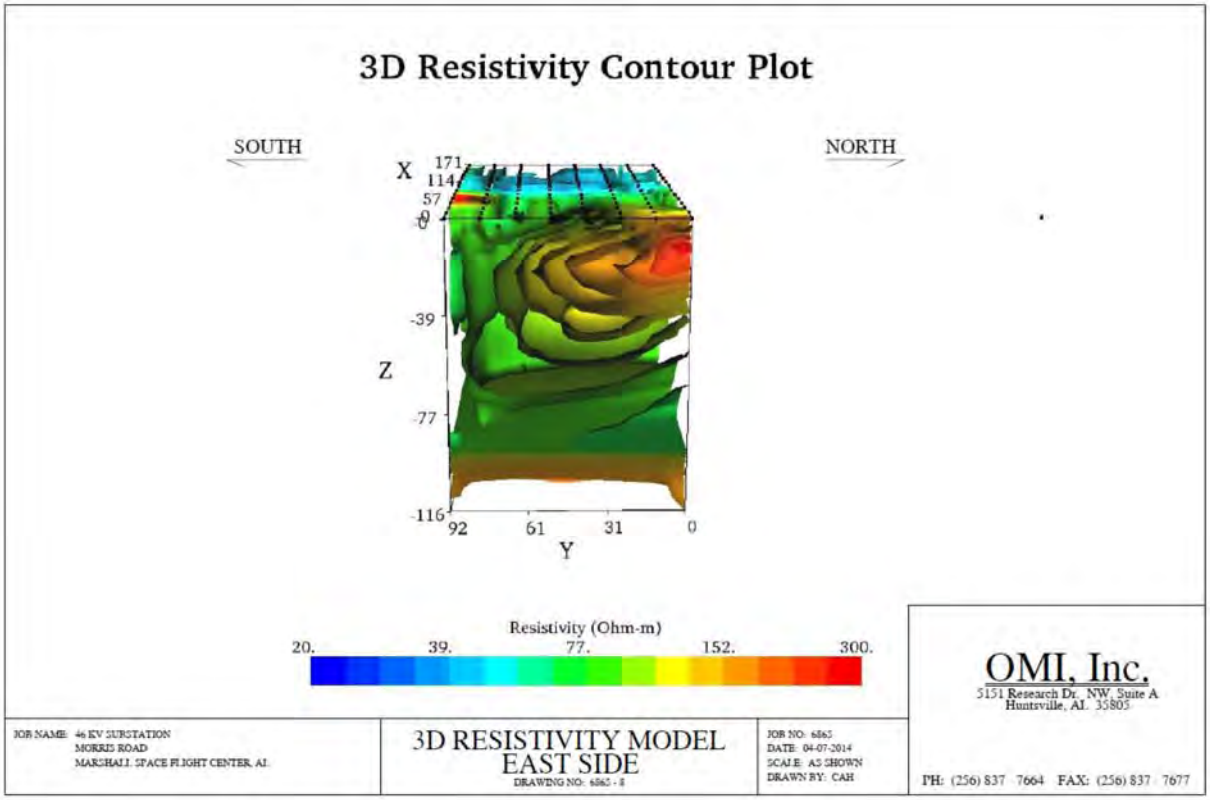
JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL
3D RESISTIVITY MODEL NORTH SIDE
DRAWING NO: 6865 - 6
JOB NO: 6865
DATE: 04-07-2014
SCALE: AS SHOWN
DRAWN BY: CAH
PH: (256) 837 - 7664 FAX: (256) 837 - 7677


3D Resistivity Contour Plot
WEST
EAST
Y
0
31
61
92
-39
Z
-77
-116
171
114
57
0
X
Resistivity (Ohm-m)
20.
39.
77.
152.
300.
OMI, Inc.
5151 Research Dr. NW, Suite A
Huntsville, AL 35805
JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL
3D RESISTIVITY MODEL
SOUTH SIDE
DRAWING NO: 6865 - 7
JOB NO: 6865
DATE: 04-07-2014
SCALE: AS SHOWN
DRAWN BY: CAH
PH: (256) 837 - 7664 FAX: (256) 837 - 7677


3D Resistivity Contour Plot
SOUTH
NORTH
X
171
114
57
0
-39
Z
-77
-116
92
61
31
0
Y
Resistivity (Ohm-m)
20.
39.
77.
152.
300.
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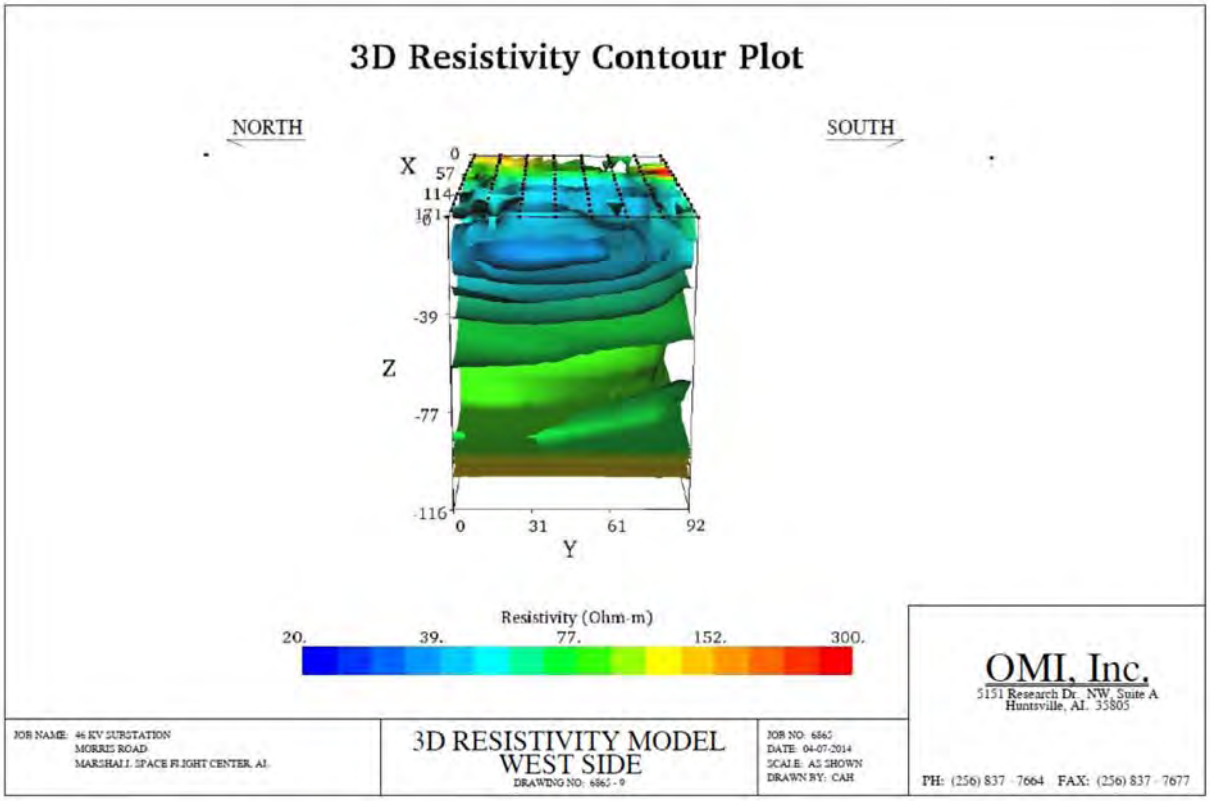
5151 Research Dr. NW, Suite A
Huntsville, AL 35805
JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL
3D RESISTIVITY MODEL
EAST SIDE
DRAWING NO: 6865 - 8
JOB NO: 6865
DATE: 04-07-2014
SCALE: AS SHOWN
DRAWN BY: CAH
PH: (256) 837 - 7664 FAX: (256) 837 - 7677


3D Resistivity Contour Plot
NORTH
SOUTH
X
0
57
114
171
-39
Z
-77
-116
0
31
61
92
Y
Resistivity (Ohm-m)
20.
39.
77.
152.
300.
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5151 Research Dr., NW, Suite A
Huntsville, AL 35805
JOB NAME: 46 KV SUBSTATION
MORRIS ROAD
MARSHALL SPACE FLIGHT CENTER, AL
3D RESISTIVITY MODEL
WEST SIDE
DRAWING NO: 6862 - 9
JOB NO: 6862
DATE: 04-07-2014
SCALE: AS SHOWN
DRAWN BY: CAH
PH: (256) 837 - 7664 FAX: (256) 837 - 7677

OMI Job No: 6865 | 46KV Substation Morris Road, Marshall Space Flight Center, AL | 2/2/2014

Resistivity Results - Line 1

Raw Data

Data#	V (mV)	I (mA)	AB (ft)	A-Spacing (ft)	Ohm-m
1	1738.784	691	30	10	48.19
2	605.207	515	60	20	45.01
3	602.869	715	90	30	48.44
4	554.249	753	120	40	56.39
5	553.624	850	150	50	62.37
6	350.019	605	180	60	66.48
7	406.204	788	210	70	69.11
8	334.443	750	240	80	68.32
9	147.88	494	270	90	51.6

Inverted Data

Layer#	Ohm-m	Thickness (ft)	Bottom Depth (ft)
1	78.99	4.232	4.232
2	55.92	1.732	5.963
3	28.85	1.839	7.802
4	20.97	2.287	10.089
5	21.53	2.665	12.754
6	29.03	2.857	15.61
7	49.5	2.531	18.142
8	108.63	2.533	20.675
9	157.98	8.094	28.769
10	163.29	11.184	39.953
11	124.38	10.911	50.864
12	20.35	20.416	71.28

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Resistivity Results - Line 2

Raw Data

Data#	V (mV)	I (mA)	AB (ft)	A-Spacing (ft)	Ohm-m
1	3175.028	686	30	10	88.64
2	1743.187	572	60	20	116.73
3	829.525	422	90	30	112.94
4	728.858	519	120	40	107.58
5	589.009	532	150	50	106.02
6	447.236	494	180	60	104.03
7	177.521	226	210	70	105.3
8	274.268	423	240	80	99.34
9	138.127	243	270	90	97.97

Inverted Data

Layer#	Ohm-m	Thickness (ft)	Bottom Depth (ft)
1	50.17	4.307	4.307
2	57.89	0.951	5.258
3	183.02	0.733	5.991
4	319.47	1.606	7.597
5	300.37	2.664	10.261
6	247.23	2.273	12.534
7	173.95	1.35	13.884
8	89.31	1.264	15.148
9	51.84	4.627	19.775
10	67.46	2.817	22.591
11	77.98	7.915	30.506
12	100.24	40.774	71.28

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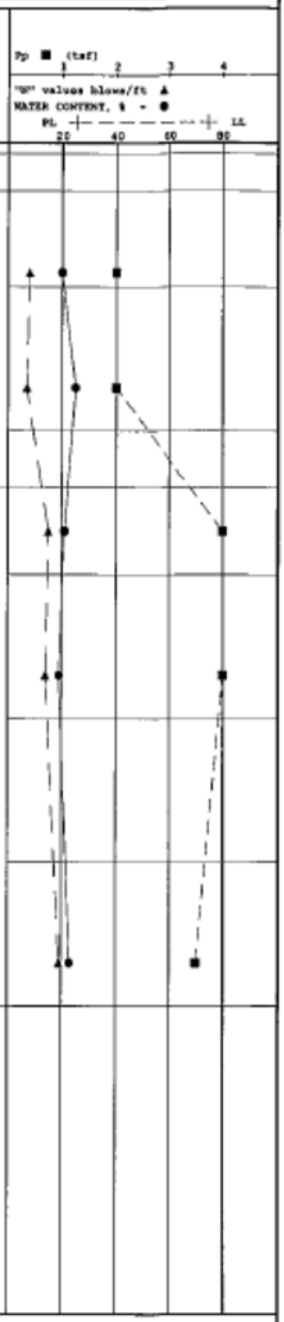
JOB NO.: 6865 JOB: 46KV Substation Morris Road LOG OF BORING: B-1

JOB LOCATION: MSFC, AL BORING LOCATION:

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (Elevation-)	BLOWS PER FT	NATURAL MOISTURE	POCKET PENT TEST
0			ASPHALT			
			DENSE GRADED BASE			
2.5			SANDY SILTY CLAY, 10% fine sand, 90% fines, medium plasticity, brownish tan, firm, moist, residuum, CL	8	20	2.0
5				7	25	2.0
7.5			SANDY SILTY CLAY, 10% medium graded sand, 90% fines, high plasticity, mottled, brown, tan, gray, stiff to very stiff, moist, residuum, CH	15	21	4.0
10				14	19	4.0
12.5						
15				19	23	3.5
			BORING TERMINATED AT 15-FT			
17.5						
20						



COMPLETION DEPTH: 15 DEPTH TO WATERINITIAL: Dry OMI,Inc.

DATE: 3/3/14 DEPTH TO WATERFINAL: Page 1 of 1

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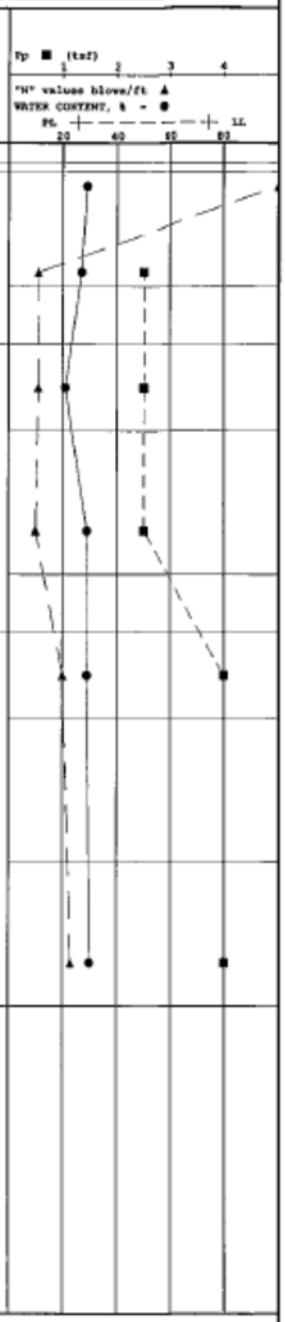
JOB NO.: 6865 JOB: 46KV Substation Morris Road LOG OF BORING: B-2

JOB LOCATION: MSFC, AL BORING LOCATION:

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (Elevation=)	BLOWS PER FT	NATURAL MOISTURE	POCKET PENT TSF
0			TOPSOIL			
			GRAVEL	100+	29	---
2.5			SANDY SILTY CLAY, 10% fine sand, 90% fines, medium plasticity, brownish tan, stiff, moist, residuum, CL	11	27	2.5
5			SANDY SILTY CLAY, 10% medium graded sand, 90% fines, high plasticity, mottled, brown, tan, gray, stiff, moist, residuum, CH	11	21	2.5
7.5				10	29	2.5
10			SANDY SILTY CLAY, 10% medium sand, 90% fines, high plasticity, red, very stiff, moist, residuum, CH	20	29	4.0
12.5						
15				23	30	4.0
			BORING TERMINATED AT 15-FT			
17.5						
20						



COMPLETION DEPTH: 15 DEPTH TO WATERINITIAL: Dry OMI,Inc.

DATE: 3/3/14 DEPTH TO WATERFINAL: Page 1 of 1

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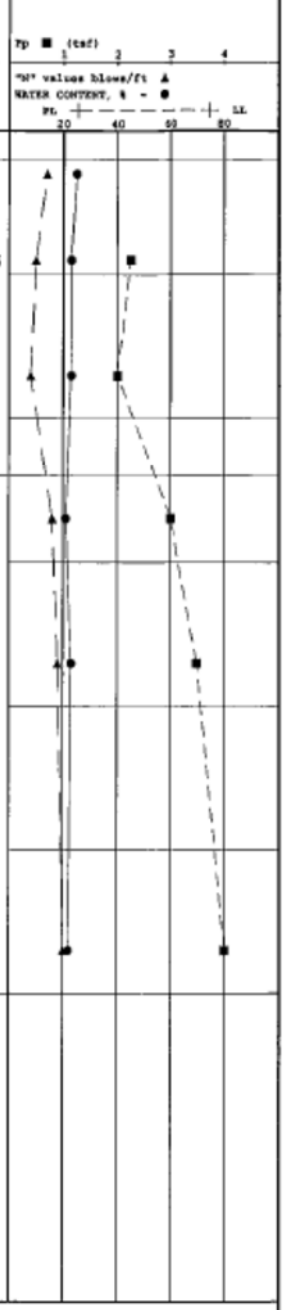
JOB NO.: 6865 JOB: 46KV Substation Morris Road LOG OF BORING: B-3

JOB LOCATION: MSFC, AL BORING LOCATION:

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (Elevation=)	BLOWS PER FT	NATURAL MOISTURE	POCKET PENT TSF
0			TOPSOIL WITH LIMESTOME GRAVEL			
			SANDY SILTY CLAY, 10% fine sand, 90% fines, medium plasticity, brownish tan, firm to stiff, moist, residuum, CL	14	25	---
2.5				10	23	2.25
				8	23	2.0
5						
			SANDY SILTY CLAY, 10% medium graded sand, 90% fines, high plasticity, mottled, brown, tan, gray, very stiff, moist, residuum, CH	16	21	3.0
7.5						
				18	23	3.5
10						
12.5						
				20	22	4.0
15			BORING TERMINATED AT 15-FT			
17.5						
20						



COMPLETION DEPTH: 15 DEPTH TO WATERINITIAL: Dry OMI,Inc.

DATE: 3/3/14 DEPTH TO WATERFINAL: Page 1 of 1

OMI, Inc.

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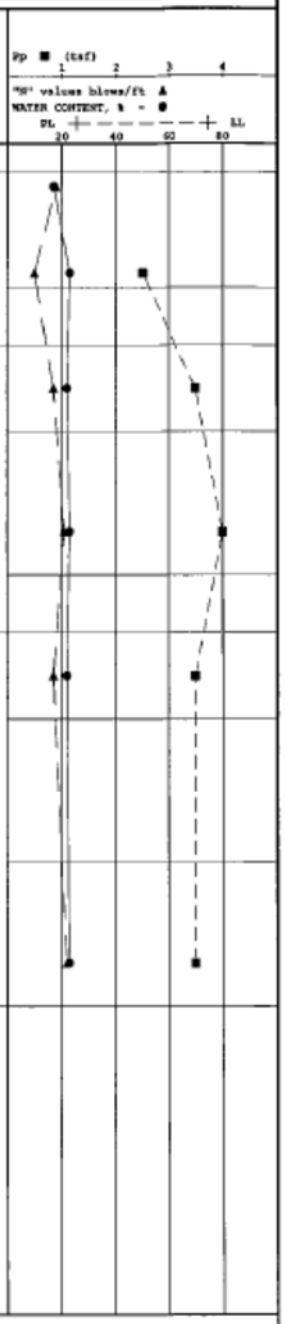
JOB NO.: 6865 JOB: 46KV Substation Morris Road LOG OF BORING: B-4

JOB LOCATION: MSFC, AL BORING LOCATION:

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL (Elevation=)	BLOWS PER FT	NATURAL MOISTURE	POCKET PENT TSF
0			TOPSOIL WITH LIMESTONE GRAVEL			
			SANDY SILTY CLAY, 10% fine sand, 90% fines, medium plasticity, brownish tan, stiff, moist, residuum, CL	18	17	---
2.5				10	23	2.5
			SANDY SILTY CLAY, 10% medium graded sand, 90% fines, high plasticity, mottled, brown, tan, gray, very stiff, moist, residuum, CH	17	22	3.5
5						
				21	23	4.0
7.5						
			SANDY SILTY CLAY with traces of chert gravel and oxides, 10% medium to coarse gravel, 90% fines, high plasticity, orangish red, very stiff, moist, residuum, CH	17	22	3.5
10						
12.5						
				22	23	3.5
15			BORING TERMINATED AT 15-FT			
17.5						
20						



COMPLETION DEPTH: 15 DEPTH TO WATERINITIAL: Dry OMI,Inc.

DATE: 3/3/14 DEPTH TO WATERFINAL: Page 1 of 1

BORING LEGEND

SOIL SYMBOLS

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAIN SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVELS 50% OR MORE OF COARSE FRACTION RETAINED ON #4 SIEVE	CLEAN GRAVELS	GW	WELL-GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN 50% OF COARSE FRACTION PASSES #4 SIEVE	CLEAN SANDS	SW	WELL-GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAIN SOILS 50% OR MORE PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS

ABBREVIATIONS:

SS- SPLIT SPOON SAMPLE

UD- UNDISTURBED SAMPLE

REC-SAMPLE RECOVERY

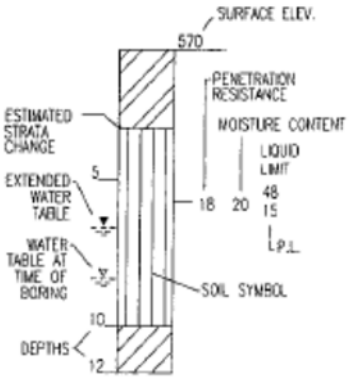
USC-VISUAL UNIFIED SOIL CLASSIFICATION

POCKET PENET- POCKET PENETROMETER READING, TSF

RQD-ROCK QUALITY DESIGNATION

FF- FRACTURE FREQUENCY PER FOOT OF CORE

KEY TO BORING RECORDS OR PROFILES



ROCK SYMBOLS

SANDSTONE

SHALE

GNEISS OR SCHIST

CONGLOMERATE

LIMESTONE OR DOLOMITE

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FIELD TEST PROCEDURES

OMI, Inc., generally follows field and laboratory testing procedures as outlined by the American Society for Testing and Materials (ASTM) and the U. S. Army Corps of Engineers. Field procedures are outlined and an overview description is provided in ASTM Standard D-420, "Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes." This document is a guide to the selection of various standards for investigating soil, rock, and ground water for earth related construction. Applicable procedures include geophysical, in-situ, and boring methods. A summary of each procedure used during this study is presented below.

SOIL DRILLING PROCEDURES

Several techniques are used to advance borings for collection of soil, rock, or ground water samples. Different techniques are used, depending on the samples desired and the soil and water conditions. Depths for sample intervals, strata changes, and boring termination or refusal are recorded to the nearest 1/10 of a foot. The techniques include the following.

Soil Borings

A) Solid stem continuous flight augers (ASTM D-1452)

B) Hollow stem continuous flight augers (ASTM D-1452)

C) Rotary drilling techniques using roller cone bits or drag bits and water with or without drilling mud or other additives to flush the hole

D) Hand augers

E) Backhoes or other excavating equipment.

Rock Borings

A) Core borings with diamond bits with double or triple core barrels (ASTM D-2113)

B) Rock borings with roller cone bit

C) Rotary hammer drilling.

Hollow and Solid Stem Auger: An auger is a center post with a continuous spiral flange wrapped around it. The post is called the stem. Augers are usually constructed in 5-foot long sections that can be coupled together. As the auger is turned and advanced into the ground; the soil "cuttings" are brought to the surface. Solid stem augers have a solid core and have to be removed from the boring to allow access for sampling tools. Hollow stem augers have the spiral flange connected to a hollow tube (stem). Sampling tools can access the bottom of the boring without removing the augers from the hole.

Rotary Borings: Rotary drilling involves the use of roller cone or drag type drill bits attached to the end of hollow drill rods. A flushing medium, normally water or bentonite slurry, is pumped through the rods to clear the cuttings from the bit face and flush them to the surface. Casing is sometimes set behind the advancing bit to prevent the hole from collapsing and to restrict the penetration of the drilling fluid into the surrounding soils. Cuttings returned to the surface by the drilling fluid are usually collected in a settling tank to allow the fluid to be re-circulated.

Hand Auger Borings: Hand auger borings are advanced by manually twisting a 4-inch diameter steel bucket auger into the ground and withdrawing it when filled to observe the sample collected. Other equipment such as post-hole diggers is sometimes used in lieu of augers to obtain shallow soil samples. Occasionally, these hand auger borings are used for driving 3-inch diameter steel tubes to obtain intact soil samples.

Test Pits: A backhoe or other construction equipment is sometimes used to excavate into soils to observe the soil and collect samples.

Core Drilling: Soil drilling methods are not normally capable of penetrating through hard cemented soil, weathered rock, coarse gravel or boulders, thin rock seams, or sound continuous rock. Material which cannot be penetrated by auger or rotary soil drilling methods at a reasonable rate is designated as "refusal material." Core drilling procedures are required to penetrate and sample refusal materials.

Prior to coring, casing may be set in the drilled hole through the overburden soils to keep the hole from caving and to prevent excessive water loss. The refusal materials are then cored according to ASTM D-2113 using a diamond bit fastened to the end of a hollow, double, or triple tube core barrel. This device is rotated at high speeds and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run, the core is brought to the surface, recovery is measured, and the core is sequentially placed in boxes and transported to our laboratory for review and storage.

SAMPLING AND TESTING IN BOREHOLES

Several techniques are used to obtain samples and data in soils; however, the most common methods in this area are:

A) Standard Penetration Testing
B) Undisturbed Sampling
C) Dynamic Cone Penetration Testing
D) Hand-Held Static Cone Penetrometer
E) Water Level Readings.

These procedures are presented below. Any additional testing techniques employed during this exploration are contained in other sections of the Appendix.

Standard Penetration Testing: At regular intervals, the drilling tools are removed and soil samples are obtained with a standard 2-inch diameter split tube or "split spoon" sampler connected to a drill rod. The sampler is first seated 6 inches to penetrate any loose cuttings then driven an additional 12 inches with blows of a 140 pound safety hammer falling 30 inches. Generally, the number of hammer blows required to drive the sampler the final 12 inches is designated the "penetration resistance" or "N" value, defined in blows per foot (bpf). The split spoon sampler is designed to retain the soil penetrated so it may be returned

to the surface for observation. Representative portions of the soil samples obtained from each split spoon sample are placed in jars, sealed, and transported to the laboratory.

The standard penetration test, when properly evaluated, provides an indication of the soil strength and compressibility. The tests are conducted according to ASTM Standard D-1586. The depths and N-values of standard penetration tests are shown on the Boring Records. Split spoon samples are suitable for visual observation and classification tests, but generally are not sufficiently intact for quantitative laboratory testing.

Undisturbed Sampling: Relatively undisturbed samples are obtained by pushing 3 inch outside diameter (OD), 30 inch long steel tubes with hydraulic pressure supplied by the drill rig into the soil at the desired sampling levels (ASTM Standard D-1587). These tubes are also known as Shelby tubes. Each tube, together with the encased soil, is removed from the ground, sealed, and transported to the laboratory. Locations and depths of undisturbed samples are shown on the Boring Records.

Dynamic Cone Penetrometer: The dynamic cone is a hand-operated penetrometer used in hand auger borings and observation pits. This test is intended to provide data that can be correlated to the standard penetration test. A 1.5-inch OD cone is seated to penetrate any loose cuttings, and then driven for 3 intervals of 1.75 inch with blows from a 15-pound weight falling 20 inches. The average number of blows required to drive the cone over 1 increment is an index to soil strength and compressibility.

Water Level Readings: Water table readings are normally taken in the borings and are recorded on the Boring Records. In sandy soils, these readings indicate the approximate location of the hydrostatic water table at the time of the field exploration. In clayey soils, the rate of water seepage into the borings is low and it is generally not possible to establish the location of the hydrostatic water table through short-term water level readings. Also, fluctuation in the water table should be expected with variations in precipitation, surface run-off, evaporation, and other factors. For long-term monitoring of water levels, it is necessary to install piezometers.

The water level reported on the Boring Records is determined by field crews immediately after the drilling tools are removed, and again several hours after the borings are completed, if possible. The time lag is

intended to permit stabilization of the ground water table which may have been disrupted by the drilling operation.

Occasionally, the borings will cave in, preventing water level readings from being obtained or trapping drilling water above the cave-in zone. The cave-in depth is measured and recorded on the Boring Records.

BORING RECORDS

The subsurface conditions encountered during drilling are reported on a Boring Record. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of coarse gravel, cobbles, etc., and observations of ground water. It also contains the driller's and the geotechnical engineer's interpretation of soil conditions between samples. Therefore, these boring records contain both factual and interpretative information. A geotechnical engineer visually classifies the soil samples and prepares the Boring Records which are the basis for all evaluations and recommendations.

ELECTRICAL RESISTIVITY

Electrical resistivity is a non-destructive, non-intrusive method of searching for the presence of sinkholes. The process includes driving a series of electrical probes into the ground at set spacings and along a line. Electrical current is then pushed between two probes and the resistivity of the soil is measured at intermediate probes. The depth of the area studies increases as the distance between the electrical probes increases. As soil materials change in consistency, which may be a result of mineralogy, moisture content, or density, the electrical resistivity or conductivity changes. Therefore, if a sinkhole is present near the resistivity profile, a change in resistivity will show up due to the changed conditions in the sinkhole. This methodology assists in looking for sinkholes in an area such as this.

OMI uses a multiple probe resistivity meter that allows 56 probes to be placed in the ground and attached to the machine at one time. A computer systematically switches between the probes sending current between two probes and measuring the resistivity between two additional probes. The computer switches through the combinations of probes to collect approximately 750 separate readings during each setup. Mathematical modeling techniques are then used to evaluate the data and the resulting resistivity is plotted using a graphical contouring program.

LABORATORY TEST PROCEDURES

OMI, Inc., generally follows laboratory testing procedures as outlined by the American Society for Testing and Materials (ASTM), the U. S. Army Corps of Engineers, and other applicable procedures. All work is initiated and supervised by qualified engineers. Laboratory tests are performed by technicians trained to perform the work according to the appropriate procedures. The equipment is well maintained and inspected and calibrated annually or as specified by ASTM.

A description of the procedures used during this exploration or study are included in this Appendix.

SOIL CLASSIFICATION

Classification of soils provides a record and general guide to the engineering properties of the soils encountered during this study. Samples obtained during the field testing (drilling) operations are visually examined and classified by the geotechnical engineer. OMI, Inc., generally follows ASTM procedure No. D-2488 "Visual-Manual Procedure for Classifying Soils." Soil consistency and relative density is based on the number of blows from the standard penetration test. Representative or special samples are then selected for laboratory testing. Soil Boring Records are developed which present the data from the field testing as well as the soil description, water level information, and other data.

MOISTURE CONTENT

Moisture content values, when used in conjunction with other data, can be a useful and inexpensive tool to the engineer as an indicator of the engineering characteristics and parameters of the soil when compared to other data. Moisture content is performed by weighing a moist sample, drying, then re-weighing the dry sample. The moisture content is expressed as a percent of the dry weight of the soil. ASTM Method D-2216 is used to determine the moisture content of soil.

OMI, Inc.

SECTION 32 31 13 – CHAIN-LINK FENCES AND GATES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Galvanized steel and Aluminum-coated steel chain-link fabric.
2. Galvanized Steel and Aluminum framework.

1.3 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, finishes of components, installation and operational clearances, gate swings, and details of post anchorage and attachment and bracing.

PART 2 – PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. Fabric: FS RR-F-191/1, Type I, zinc-coated steel wire with minimum coating weight of 2.0 ounces of zinc per square foot of coated surface. Fabric shall be fabricated of 9-gauge wire woven in 2- inch mesh. Fabric height shall be 6 feet. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.2 INDUSTRIAL FENCE FRAMING

A. Posts: FS RR-F-191/3, zinc-coated; Class 1 Grade A or B, steel pipe; Class 3, formed steel sections; or Class 6, steel square sections. Class 4, steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same class throughout the fence. Gate post shall be either round or square, subject to the limitation specified in FS RR-F-191/3.

B. Braces and Rails: FS RR-F-191/3, zinc-coated, Class 1, Grade A or B, steel pipe, size SP1. Class 3, formed steel sections, size FS1, conforming to FS RR-F-191/3, may be used as braces if Class 3 line posts are furnished.

C. Accessories: FS RR-F-191/4. Ferrous accessories shall be zinc coated. Truss rods

shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustments. Barbed wire support arms shall be the single V arm type and of the design required for the post furnished.

2.3 GATES

A. FS RR-F-191/2. Gate shall be the type and swing shown. Gate frames shall be constructed of Class 1 Grade A or B, steel pipe, size SP5, as specified in FS RR-F-191/3. Gate fabric shall be as specified for chain-link fabric. Each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence. Gate leaves more than 10 feet wide shall have either intermediate members and diagonal truss rods, or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Intermediate braces shall be provided on all gate frames with an electro-mechanical lock. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position.

2.4 TENSION WIRE AND FITTINGS

A. Metallic-Coated Steel Tension Wire: 0.177- inch- diameter, marcelled tension wire complying with ASTM A 824 at locations indicated.

B. Fittings: Provide fittings for a complete fence installation, including special fittings for corners. Comply with ASTM F 626.

2.5 CAST-IN-PLACE CONCRETE

A. Concrete: ASTM C 94, using 3/4-inch maximum size aggregate, and having minimum compressive strength of 3000-psi at 28 days. Submit mix design for approval.

2.6 PADLOCKS

A. ASTM F 883, Type PO1, Grade 2, Size 1-3/4-inch. Padlocks shall be keyed alike and each lock shall be furnished with two keys.

2.7 BARBED WIRE

A. ASTM A 121 zinc-coated, Class 1, 13 gauge wire with 13-½, gauge 4 point barbs spaced no more than 6-inches apart.

PART 3 – EXECUTION

3.1 GENERAL

A. Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 10-feet. Terminal (corner, gate and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet.

3.2 POSTS

A. Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 18 inches in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 1 inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Class 3 type line posts may be mechanically driven if the driven posts develop strengths at least equal to posts set in concrete and if rock is not encountered. Driven posts shall be set to a minimum depth of 3 feet and shall be protected with drive caps when being set.

3.3 BRACES AND TRUSS RODS

A. Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal.

3.4 TENSION WIRES

A. Tension wires shall be installed along the top and bottom of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top 1 foot of the installed fabric. Bottom tension wire shall be installed within the bottom 6-inches of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

3.5 CHAIN LINK FABRIC

A. Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be

spaced at approximately 15- inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 15-inch intervals and fastened to all rails and tension wires at approximately 24-inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 2-inches (+ ½-inch) above the ground.

3.6 BARBED WIRE SUPPORTING ARMS AND BARBED WIRE

A. Barbed wire supporting arms and barbed wire shall be installed as indicated and as recommended by the manufacturer. Supporting arms shall be anchored to the posts in a manner to prevent easy removal with hand tools. Barbed wire shall be pulled taut and attached to the clips or other means that will prevent easy removal.

3.7 GATES

A. Gates shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. Padlocks shall be attached to gates or gate posts with chains and hinge pins, and hardware shall be welded or otherwise secured to prevent removal.

3.8 GROUNDING

A. Fences crossed by power lines of 600 volts or more and conductors that are not enclosed in a grounded metal raceway shall be grounded at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be ¾-inch by 10-foot-long copper clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable, electrodes shall be buried a minimum of 12 inches deep and radially from the fence. The top of the electrode shall be not less than 2 feet or more than 8 feet from the fence. Ground conductor shall be clamped to the fence on two (2) foot intervals and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. After installation the total resistance of fence to ground shall not be greater than 25 ohms. Each gate panel shall be bonded with a flexible bond strap to its gate post.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to adjust gates.

END OF SECTION 32 31 13

SECTION 32 92 00 – TURF AND GRASSES

PART 1 - GENERAL

1.1 Description of work: This specification covers the furnishing and installation of seed and sod. Products shall match existing material and/or shall be as directed by the Contracting Officer. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

PART 2 - PRODUCTS

2.1 Seed shall be the latest season's crop and shall be delivered in original sealed packages bearing the producer's guaranteed analysis for percentages of mixtures and pure live seed. Seed shall be labeled in conformance with U.S. Department of Agriculture rules and regulations under the Federal Seed Act and applicable ALDOT Standard Specifications for Highway Construction,. Section 860. Weed seed shall not exceed 1 percent by weight of the total mixture. Seed mixes shall be according to the following table:

ZONE 1 - AREAS SUBJECT TO FREQUENT MOWING REQUIRED POUNDS PER ACRE {KILOGRAMS PER HECTARE} OF PURE LIVE SEED				
Date of Planting	Jan. 1 to Feb. 29	Mar. 1 to May 15	May 16 to August 15	Aug. 16 to Dec. 31
Annual Ryegrass	25			25
Hulled Bermudagrass		15	20	
Notes	*			*
Required Permanent Plant	**Bermudagrass**			
* Requires seeding in stubble during the following month of March for the establishment of permanent plants.				

2.2 Sod shall be nursery grown, field sod, certified sod, or approved sod as classified in ALDOT Specification Section 654.

2.3 Sprigs shall be healthy living stems, stolons, or rhizomes and attached roots of grass without adhering soil. Sprigs shall include two to three nodes, shall be 4 to 6 inches long, and shall be obtained from approved sources where the sod is heavy and dense. Harvesting and planting operations shall be coordinated to prevent exposure of sprigs to the sun for more than 30 minutes before covering and moistening.

2.4 Water shall not contain elements toxic to plant life.

2.5 Mulching with straw, hay or other specified materials shall be applied according to Section 860, Roadside Improvement Materials of ALDOT Standard Specifications for Highway Construction. Hay or straw shall not contain nor introduce grass seed foreign to the type required per this section.

PART 3 - EXECUTION

3.1 Provision for furnishing topsoil, ground preparation including fertilizers, ground preparation for planting, establishing grass or other vegetative cover, sodding, and mulching shall be done per ALDOT Spec. Sections 650, 651, 652, 654 and 656,as applicable.

3.2 Preparation: Except on slopes steeper than 2 horizontal to 1 vertical, the soil shall be tilled to a depth of at least 4 inches. On slopes between 2 horizontal to 1 vertical and 1 horizontal to 1 vertical tillage, depths shall be 2 inches. On slopes steeper than 1 horizontal to 1 vertical, no tillage will be permitted.

3.3 Application:

A. Planting Seasons and Conditions: Planting shall not be done when the ground is frozen, snow covered, or in an unsatisfactory condition for planting.

B. Grass seed shall be distributed in conformance with the following table according to the applicable season of the year, and shall be watered sufficiently to establish a healthy stand of grass during the growing season. Straw or hay shall be strewn over seed to protect seed until establish growth occurs.

C. During months not suitable for seeding of Bermuda and Fescue grasses, the Contractor shall stabilize erosive soils by sowing Annual Rye Grass. If grass sown during the winter months does not germinate and grow, the Contractor shall stabilize erosive areas by re-seeding, spreading straw, applying mulch, jute netting or other approved means and material. At the appropriate season Bermudagrass or Fescue shall be sown at the rates shown in the table in Paragraph 2.1 accordance with these specifications.

D. Seeding:

1. Broadcast: Seed shall be broadcast uniformly. Cover seed to an average depth of 1/4 inch. Distribute straw or hay over seeded area.
2. Drill: Drill seed to an average depth of ½" or as recommended by the local Agricultural County Extension Service for type of seed and application.
3. Hydroseeding: Utilizing cellulosic fiber, fertilizer and seed spread with one application in accordance with equipment manufacturer's written instructions for the type of seed.
4. Immediately after broadcast or drill seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of length. Immediately after firming, water the soil to a depth of 6 to 8 inches.

E. When required by drawings, sod shall be installed instead of seed and be accomplished in accordance with the ALDOT Specification Section 654.

F. When spot sodding, the sod shall be cut into plugs 2 inches square or 2 inches in diameter. The individual pieces of sod shall be placed on 12 - inches centers and pressed firmly into the soil by foot pressure or by tamping.

G. After sod pieces have been placed in position, the sodded area shall be rolled or tamped so that air pockets are eliminated.

H. Water shall be applied to the sodded areas at a rate sufficient to ensure thorough wetting of the soil to a depth of at least 4 inches.

G. When required by contract drawings, sprigging shall be accomplished instead of seeding. Sprigs shall be planted in such quantity as to provide a minimum of 25 viable sprigs or 108 linear inches of viable sprigs per square yard of areas. Immediately after sprigging operations have been completed, the planted area shall be firmed with a cultipacker or a roller. Water shall be applied at the time of sprigging operations wetting the soil to a depth of 4 inches.

H. Protection of Turfed Areas: Immediately after seeding, sodding, or sprigging, the area shall be protected against traffic or other use by erecting barricades, as required, and approved signs shall be placed at appropriate intervals until final acceptance.

3.4 ALDOT specifications shall be applied for general construction and methods

END OF SECTION 32 92 00

SECTION 33 05 13 – UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Ducts in direct-buried duct banks.
2. Ducts in concrete-encased duct banks.
3. Handholes and handhole accessories.
4. Manholes and manhole accessories.

B. Related Sections include the following:

1. Division 16 Section "Grounding and Bonding" for grounding electrodes, counterpoise conductors, clamps and connectors for grounding metallic manhole and handhole accessories, and testing of grounds.

1.3 SUBMITTALS

A. The following shall be submitted in accordance with Section 01330, “Submittal Procedures,” in sufficient detail to show full compliance with the Contract Documents.

B. Product Data: For the following:

1. Manhole and handhole hardware.
2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
3. Duct-bank materials, including spacers and miscellaneous components.
4. Warning tape.

C. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:

1. For manholes:

a. Duct sizes and locations of duct entries.
b. Reinforcement details.
c. Manhole cover design.
d. Step details.
e. Grounding details.
f. Dimensioned locations of cable rack inserts, pulling- in irons, and sumps.

2. For precast manholes and handholes, Shop Drawings shall be signed and sealed by a qualified professional engineer, and shall show the following:

    a. Construction of individual segments.
    b. Joint details.
    c. Design calculations.

D. Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings.

E. Product Certificates: For concrete and steel used in underground precast manholes, according to ASTM C 858.

F. Product Test Reports: Indicate compliance of manholes with ASTM C 857 and ASTM C 858, based on factory inspection.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories Including Ducts for Communications: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify government representative at least five (5) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without government’s representative written permission.

1.7 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities and site grading, as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by government's representative.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable -support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of amount installed.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Underground Precast Concrete Utility Structures:

   a. Carder Concrete Products.
   b. Christy Concrete Products, Inc.
   c. Elmhurst-Chicago Stone Co.
   d. Riverton Concrete Products.
   e. Rotondo Precast/Old Castle.
   f. Utility Vault Co.
   g. Wausau Concrete Co.
   h. Other Local Suppliers

2. Frames and Covers:

   a. Campbell Foundry Co.
   b. East Jordan Iron Works, Inc.
   c. McKinley Iron Works, Inc.
   d. Neenah Foundry Co.

e. Other Local Suppliers

3. Nonmetallic Ducts and Accessories:

a. Arnco Corp.
b. Beck Manufacturing Inc.
c. Cantex, Inc.
d. Certainteed Corp.; Pipe & Plastics Group.
e. ElecSys, Inc.
f. Electri-Flex Co.
g. Ipex, Inc.
h. Lamson & Sessions; Carlon Electrical Products.
i. Manhattan/CDT/Cole -Flex.
j. Spiraduct/AFC Cable Systems, Inc.
k. Other Local Suppliers.

2.2 CONDUIT

A. Conduit and fittings are specified in Division 16 Section "Raceways and Boxes."

2.3 DUCTS

A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

B. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-80-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

C. Plastic Utilities Duct: NEMA TC 6, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 9.

D. Plastic Utilities Duct: NEMA TC 6, Type DB-60-PVC, ASTM F 512, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 9.

E. Plastic Utilities Duct: NEMA TC 8, Type EB-35-PVC, ASTM F 512, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 9.

F. Plastic Utilities Duct: NEMA TC 8, Type DB-120-PVC, ASTM F 512, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 9.

2.4 HANDHOLES

A. Cast-Metal Boxes: Cast aluminum, with outside flanges and recessed, gasketed cover for flush mounting and with nonskid finish and legend on cover. Unit, when buried, shall be designed to support AASHTO H10 loading.

B. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with

cast- aluminum frame and access door assembly as the top of handhole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling- in irons and other built- in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading.

C. Fiberglass Handholes: Molded fiberglass, with 6-inch-square cable entrance at each side and weatherproof cover with nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading.

D. Cover Legend: "ELECTRIC."

2.5 ACCESSORIES

A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts.

B. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 2-inch-diameter eye and 1-inch × 4-inch bolt.

C. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

D. Pulling and Lifting Irons in Floor: 7/8-inch diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.

E. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

F. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID × 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

G. Tested Ultimate Pullout Strength: 12,000-lbf minimum.

H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

I. Cable Stanchions: Hot-rolled, hot-dip-galvanized, T-section steel; 2-1/4-inch size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

J. Cable Arms: 3/16-inch-thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 12 inches wide × 14 inches long and arranged for secure mounting in horizontal position at any location on cable stanchions.

K. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

L. Grounding Materials: Comply with Division 16 Section "Grounding and Bonding."

M. Ladder: UL-listed, heavy-duty wood specifically designed for electrical manhole use. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches.

N. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35° F. Capable of withstanding temperature of 300° F without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

O. Warning Tape: Underground-line warning tape specified in Division 16 Section "Electrical Identification."

P. Concrete Warning Planks: Nominal 12-inches × 24-inches × 3-inches in size, manufactured from 6000-psi concrete.

1. Color: Red dye added to concrete during batching.
2. Mark each plank with "ELECTRIC" in 2-inch-high, 3/8-inch-deep letters.

2.6 CONSTRUCTION MATERIALS

A. Concrete: Concrete and reinforcement are specified in Division 3 Section "Cast-in-Place Concrete."

PART 3 - EXECUTION

3.1 APPLICATION

A. Underground Ducts for Electrical Cables Higher than 600 V: Type EPC-40-PVC, concrete-encased duct bank.

B. Underground Ducts for Electrical Feeders: Type EB-20-PVC, concrete-encased duct bank.

C. Underground Ducts for Electrical Branch Circuits: Type DB-60-PVC, direct-buried duct bank.

D. Underground Ducts for Telephone Utility Service: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-80-PVC when crossing roads and railroads.

E. Underground Ducts for Communication Circuits: Type EPC-40-PVC, direct-buried duct bank.

F. Manholes: Underground precast concrete utility structures.

G. Manholes: Cast-in-place concrete.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 2 Section “Earthwork” but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

D. Restore disturbed pavement.

3.3 CONDUIT AND DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down towards manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use manufactured elbows and stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet, both horizontally and vertically, at other locations.

C. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

D. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches o.c. for 5-inch ducts and vary proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

E. Building Entrances: Make a transition from underground duct to conduit at least 10 feet outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcement in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Direct-Buried, Nonencased Ducts at Nonwaterproofed Wall Penetrations: Install a Schedule 40, galvanized steel pipe sleeve for each duct. Caulk space between conduit and sleeve with duct-sealing compo0und on both sides for moisture-tight seal.
3. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

F. Concrete-Encased, Nonmetallic Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts and secure separators to earth and to ducts to prevent floating during concreting. Stagger spacers approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plane and install ¾-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. Reinforcement: Reinforce duct banks where they cross disturbed earth and where indicated.
4. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Minimum Clearances between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
6. Depth: Install top of duct bank at least 24 inches below finished grade in nontraffic areas and at least 30 inches below finished grade in vehicular traffic areas, unless otherwise indicated.

G. Direct-Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follow:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts.
2. Install expansion fittings as shown on Shop Drawings.
3. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 2 section “Earthwork” for pipes less than 6 inches in nominal diameter.
4. Backfill: Install backfill as specified in Division 2 section “Earthwork.” After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally.
5. Minimum Clearances between Ducts: 3 inches between ducts for like services and 6 inches between power and signal ducts.
6. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.

H. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank.

I. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.

J. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares

3.4 HANDHOLE INSTALLATION

A. Elevation: Install handholes with depth as indicated. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface 1 inch above grade.

B. Drainage: Install drains in bottom of units where indicated. Coordinate with drainage provisions indicated.

C. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

D. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

E. Grounding: Install ground rod through floor in each structure with top protruding 4 inches above floor. Seal floor opening against water penetration with waterproof nonshrink grout. Ground exposed metal components and hardware with bare-copper ground conductors. Train conductors neatly around corner. Use cable clamps secured with expansion anchors to attach ground conductors.

F. Precast Concrete Manhole Installation: Unless otherwise indicated, comply with ASTM C 891.

1. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

3.5 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

B. Grounding: Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 16.

C. Duct Integrity: Pull aluminum or wood test mandrel through duct to prove joint integrity

and test for out-of-round duct. Provide mandrel equal to 80 percent fill of the duct. If obstructions are indicated, remove obstructions and retest.

D. Correct installation if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.6 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surface of handholes. Remove foreign material.

END OF SECTION 33 05 13