INTERIOR DISTRIBUTION SYSTEM. Manual or automatic control and protective or signal devices required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 11.

d. Provide motors in accordance with NEMA MG 11 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances.

e. Provide inverter duty premium efficiency motors for use with variable frequency drives.

f. Provide variable frequency drives for motors.

2.4 SPLIT-SYSTEM WATER CHILLER, VAPOR COMPRESSION TYPE

Total chiller system shall be constructed and rated in accordance with ARI 550/590. Individual chiller components shall be constructed and rated in accordance with the applicable ARI standards. Chiller system shall be conform to ANSI/ASHRAE 15 & 34. The chiller shall be ASHRAE 90.1 - SI complaint and 10 CFR Part 433, 434 and 435 efficiency performance standards for federal construction. The manufacturer shall provide certification of compliance. Chiller shall be assembled, leak-tested, charged (refrigerant and oil), and adjusted at the job site in strict accordance with manufacturer's recommendations. Unit components delivered separately shall be sealed and charged with a nitrogen holding charge. Unit assembly shall be completed in strict accordance with manufacturer's recommendations. Chiller shall operate within capacity range and speed recommended by the manufacturer. Parts weighing 50 pounds or more which must be removed for inspection, cleaning, or repair, shall have lifting eyes or lugs. Chiller shall include all customary auxiliaries deemed necessary by the manufacturer for safe, controlled, automatic operation of the equipment. Chiller's water cooler shall be provided with standard water boxes with grooved mechanical or flanged connections. Chillers shall operate at partial load conditions without increased vibration over normal vibration at full load, and shall be capable of continuous operation down to minimum capacity. As a minimum, chiller shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Refrigerant and oil

b. Structural base

c. Chiller refrigerant circuit

d. Controls package

2.4.1 Compressor-Chiller Unit

As a minimum, the compressor-chiller unit shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Scroll, reciprocating, or rotary screw compressor

b. Compressor driver, electric motor

c. Compressor driver connection

d. Water cooler (evaporator)

2.4.2 Condensing Unit

As a minimum, the condensing unit shall include the following components as defined in paragraph CHILLER COMPONENTS.

a. Scroll compressor

b. Compressor driver, electric motor

c. Compressor driver connection

d. Air condenser

2.4.3 Remote Water Cooler (Evaporator)

2.4.3.1 Shell and Tube Type

Cooler shall be constructed and rated in accordance with AHRI 480. Cooler shall be of the shell-and-coil or shell-and-tube type design. Cooler's refrigerant side shall be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Cooler's water side shall be designed and factory pressure tested for not less than 150 psi. Cooler shell shall be constructed of seamless or welded steel. Tubes shall be seamless copper, plain, integrally finned with smooth bore or integrally finned with enhanced bore. Each tube shall be individually replaceable. Tubes shall be installed into carbon mild steel tube sheets by rolling. Tube baffles shall be properly spaced to provide adequate tube support and cross flow. Cooler shall be skid-mounted. Refrigerant circuit shall be complete with liquid solenoid valve and expansion device capable of modulating to the minimum step of capacity unloading. For the water side of water cooler, performance shall be based on a water velocity not less than 3 fps and not more than 12 fps and a fouling factor of 0.00025.

2.4.3.2 Brazed Plate Type

Cooler shall be constructed and rated in accordance with AHRI 480. Cooler shall be of the brazed plate design. Cooler's refrigerant side shall be designed and factory pressure tested to comply with ANSI/ASHRAE 15 & 34. Cooler's water side shall be designed and factory pressure tested for not less than 150 psi. Cooler shell shall be constructed of stainless steel plates brazed together with copper. Refrigerant circuit shall be complete

with liquid solenoid valve and expansion device capable of modulating to the minimum step of capacity unloading. For the water side of water cooler, performance shall be based on a water velocity not less than 3 fps and not more than 12 fps and a fouling factor of 0.00025.

2.4.4 Remote Air-Cooled Condenser

Condenser shall be a factory-fabricated and assembled unit, consisting of coils, fans, and condenser fan motors. Condenser shall be constructed and rated in accordance with ANSI/AHRI 460. Manufacturer shall certify that the condenser and associated equipment are designed for the submitted condensing temperature. For design conditions, if matched combination catalog ratings matching remote condensers to compressors are not available, the Contractor shall furnish a crossplotting of the gross heat rejection of the condenser against the gross heat rejection of the compressor, for the design conditions to show the compatibility of the equipment furnished.

2.4.4.1 Condenser Casing

Condenser casing shall be aluminum not less than 0.080 inch or hot-dip galvanized steel not lighter than 18 gauge. Condensers having horizontal air discharge shall be provided with discharge baffle to direct air upward, constructed of the same material and thickness as the casing.

2.4.4.2 Coil

Condenser coil shall be of the extended-surface fin-and-tube type and shall be constructed of seamless copper tubes with compatible aluminum fins. Fins shall be soldered or mechanically bonded to the tubes and installed in a metal casing. Coils shall be circuited and sized for a minimum of 5 degrees F subcooling and full pumpdown capacity. Coil shall be factory leak and pressure tested after assembly in accordance with ANSI/ASHRAE 15 & 34. Coil shall be entirely coated with the manufacturer's standard epoxy or vinyl coating.

2.4.4.3 Fans

Fans shall be propeller type. Fans shall be direct or V-belt driven. Fans shall be statically and dynamically balanced.

2.4.4.4 Condenser Sizing

For design conditions, submit a cross-plot of net refrigeration effect of compressor to establish net refrigeration effect and compatibility of equipment furnished.

2.4.4.5 Low Ambient Control

Provide factory mounted head pressure control for operation during low ambient conditions. Head pressure shall be controlled by fan cycling. Low ambient control shall permit compressor operation down to 40 degrees F.

2.5 CHILLER COMPONENTS

2.5.1 Refrigerant and Oil

Refrigerants shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with

ANSI/ASHRAE 15 & 34. Refrigerants classified by the EPA as Class 2 shall not be allowed with the exception of R-123.

2.5.2 Structural Base

Chiller and individual chiller components shall be provided with a factory-mounted structural steel base (welded or bolted) or support legs. Chiller and individual chiller components shall be isolated from the building structure by means of vibration isolators with published load ratings. Vibration isolators shall have isolation characteristics as recommended by the manufacturer for the unit supplied and the service intended.

2.5.3 Chiller Refrigerant Circuit

Chiller refrigerant circuit shall be completely piped and factory leak tested. For multicompressor units, not less than 2 independent refrigerant circuits shall be provided. Circuit shall include as a minimum a combination filter and drier, combination sight glass and moisture indicator, liquid-line solenoid valve for reciprocating, an electronic or thermostatic expansion valve with external equalizer, charging ports, compressor service valves for field-serviceable compressors, and superheat adjustment.

2.5.4 Controls Package

Chiller shall be provided with a complete factory-mounted, prewired electric or microprocessor based operating and safety control system. Controls package shall contain as a minimum a digital display or acceptable gauges, an on-auto-off switch, motor starters, disconnect switches, power wiring, and control wiring. Controls package shall provide operating controls, monitoring capabilities, programmable setpoints, safety controls, and EMCS interfaces as defined below.

2.5.4.1 Operating Controls

Chiller shall be provided with the following adjustable operating controls as a minimum.

a. Leaving chilled water temperature control

b. Adjustable timer or automated controls to prevent a compressor from short cycling

c. Automatic lead/lag controls (adjustable) for multi-compressor units

d. Load limiting

e. System capacity control to adjust the unit capacity in accordance with the system load and the programmable setpoints. Controls shall automatically re-cycle the chiller on power interruption.

f. Startup and head pressure controls to allow system operation at all ambient temperatures down to 40 degrees F

g. Fan sequencing for air-cooled condenser

2.5.4.2 Monitoring Capabilities

During normal operations, the control system shall be capable of monitoring and displaying the following operating parameters. Access and operation of display shall not require opening or removing any panels or doors.

a. Entering and leaving chilled water temperatures

b. Self diagnostic

c. Operation status

d. Operating hours

e. Number of starts

f. Compressor status (on or off)

g. Refrigerant discharge and suction pressures

h. Oil pressure

2.5.4.3 Programmable Setpoints

The control system shall be capable of being reprogrammed directly at the unit. The programmable setpoints shall include the following as a minimum.

a. Leaving Chilled Water Temperature

b. Time Clock/Calendar Date

2.5.4.4 Safety Controls with Manual Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which require manual reset.

a. Low chilled water temperature protection

b. High condenser refrigerant discharge pressure protection

c. Low evaporator pressure protection

d. Chilled water flow detection

e. High motor winding temperature protection

f. Low oil flow protection if applicable

g. Motor current overload and phase loss protection

2.5.4.5 Safety Controls with Automatic Reset

Chiller shall be provided with the following safety controls which automatically shutdown the chiller and which provide automatic reset.

a. Over/under voltage protection

b. Chilled water flow interlock

c. Phase reversal protection

2.5.4.6 Remote Alarm

During the initiation of a safety shutdown, a chiller's control system shall be capable of activating a remote alarm bell. In coordination with the chiller, the Contractor shall provide an alarm circuit (including transformer if applicable) and a minimum 4 inch diameter alarm bell. Alarm circuit shall activate bell in the event of machine shutdown due to the chiller's monitoring of safety controls. The alarm bell shall not sound for a chiller that uses low-pressure cutout as an operating control.

2.5.4.7 Energy Management Control System (EMCS) Interface

The control system shall be capable of communicating all data to a remote integrated DDC processor through a single shielded cable. The data shall include as a minimum all system operating conditions, capacity controls, and safety shutdown conditions. The control system shall also be capable of receiving at a minimum the following operating commands.

a. Remote Unit Start/Stop

b. Remote Chilled Water Reset

2.5.5 Compressor(s)

2.5.5.1 Scroll Compressor(s)

Compressors shall be of the hermetically sealed design. Compressors shall be mounted on vibration isolators to minimize vibration and noise. Rotating parts shall be statically and dynamically balanced at the factory to minimize vibration. Lubrication system shall be centrifugal pump type equipped with a means for determining oil level and an oil charging valve. Crankcase oil heater shall be provided if standard or if available as an option. If provided, the crankcase oil heater shall be controlled as recommended by the manufacturer.

2.6 ACCESSORIES

2.6.1 Refrigerant Leak Detector

Detector shall be the continuously-operating, halogen-specific type. Detector shall be appropriate for the refrigerant in use. Detector shall be specifically designed for area monitoring and shall include a single sampling point installed where indicated. Detector design and construction shall be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector shall have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm). Detector shall be supplied factory-calibrated for the appropriate refrigerant(s). Detector shall be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant(s) in use. The detector's relay shall be capable of initiating corresponding alarms and ventilation systems as indicated on the drawings. Detector shall be provided with a failure relay output that energizes when the monitor detects a fault in its operation.

2.6.2 Refrigerant Relief Valve/Rupture Disc Assembly

The assembly shall be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly shall be in accordance with ASME BPVC SEC VIII D1 and ANSI/ASHRAE 15 & 34. The assembly shall be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc shall be the non-fragmenting type.

2.6.3 Refrigerant Signs

Refrigerant signs shall be a medium-weight aluminum type with a baked enamel finish. Signs shall be suitable for indoor or outdoor service. Signs shall have a white background with red letters not less than 0.5 inches in height.

2.6.3.1 Installation Identification

Each new refrigerating system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.6.4 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.6.5 Bolts and Nuts

Bolts and nuts, except as required for piping applications, shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.7 FABRICATION

2.7.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.7.2 Factory Applied Insulation

Chiller shall be provided with factory installed insulation on surfaces

subject to sweating including the water cooler, suction line piping, economizer, and cooling lines. Insulation on heads of coolers may be field applied, however it shall be installed to provide easy removal and replacement of heads without damage to the insulation. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor per manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

2.8 SUPPLEMENTAL COMPONENTS/SERVICES

2.8.1 Chilled Water Piping and Accessories

Chilled and condenser water piping and accessories shall be provided and installed in accordance with Section 23 05 15 COMMON PIPING FOR HVAC.

2.8.2 Refrigerant Piping

Refrigerant piping for split-system water chillers shall be provided and installed in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.8.3 Temperature Controls

Chiller control packages shall be fully coordinated with and integrated with 23 09 23.13 20 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.

PART 3 EXECUTION

3.1 INSTALLATION

Installation of water chiller systems including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the manufacturer's written installation instructions, including the following:

1. Water chiller - installation instructions

3.1.1 Refrigeration System

3.1.1.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ANSI/ASHRAE 15 & 34. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, water coolers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include

isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Concrete for foundations shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

3.1.1.2 Field Refrigerant Charging

a. Initial Charge: Upon completion of all the refrigerant pipe tests, the vacuum on the system shall be broken by adding the required charge of dry refrigerant for which the system is designed, in accordance with the manufacturer's recommendations. Contractor shall provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Upon satisfactory completion of the system performance tests, any refrigerant that has been lost from the system shall be replaced. After the system is fully operational, service valve seal caps and blanks over gauge points shall be installed and tightened.

b. Refrigerant Leakage: If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant shall be pumped into the system receiver or other suitable container. The refrigerant shall not be discharged into the atmosphere.

c. Contractor's Responsibility: The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the specified requirements including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.1.1.3 Oil Charging

Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the performance testing period, and upon the satisfactory completion of the tests, the oil shall be drained and replaced with the second charge.

3.1.2 Mechanical Room Ventilation

Mechanical ventilation systems shall be in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.1.3 Field Applied Insulation

Field installed insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.1.4 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.2 MANUFACTURER'S FIELD SERVICE

The services of a factory-trained representative shall be provided for 2 days. The representative shall advise on the following:

a. Hermetic machines:

(1) Testing hermetic water-chilling unit under pressure for refrigerant leaks; evacuation and dehydration of machine to an absolute pressure of not over 300 microns.

(2) Charging the machine with refrigerant.

(3) Starting the machine.

3.3 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. At least one week before the official equipment warranty start date, all condenser coils on air-cooled water chillers and split-system water chillers shall be cleaned in accordance with the chiller manufacturer's instructions. This work covers two coil cleanings. The condenser coils shall be cleaned with an approved coil cleaner by a service technician, factory trained by the chiller manufacturer. The condenser coil cleaner shall not have any detrimental affect on the materials or protective coatings on the condenser coils. Testing, adjusting, and balancing shall be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING.

3.4 FIELD ACCEPTANCE TESTING

3.4.1 Test Plans

a. Manufacturer's Test Plans: Within 120 calendar days after contract award, submit the following plans:

(1) Water chiller - field acceptance test plan

b. Coordinated testing: Indicate in each field acceptance test plan

when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of condenser controls which interlock and interface with controls factory prewired or external controls for the equipment provided under Section 23 09 23.13 20, BACNET DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC.

c. Test procedure: Indicate in each field acceptance test plan each equipment manufacturers published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer.

   Each test plan shall include the required test reporting forms to be completed by the Contractor's testing representatives. Procedures shall be structured to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control.

   Controller shall be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

d. Performance variables: Each test plan shall list performance variables that are required to be measured or tested as part of the field test.

   Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Chiller manufacturer shall furnish with each test procedure a description of acceptable results that have been verified.

   Chiller manufacturer shall identify the acceptable limits or tolerance within which each tested performance variable shall acceptably operate.

e. Job specific: Each test plan shall be job specific and shall address the particular condenser and particular conditions which exist in this contract. Generic or general preprinted test procedures are not acceptable.

f. Specialized components: Each test plan shall include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3.4.2 Testing

a. Manufacturer's recommended testing: Conduct the manufacturer's recommended field testing in compliance with the approved test plan. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field acceptance testing.

b. Operational test: Conduct a continuous 24 hour operational test for each item of equipment. Equipment shutdown before the test period is completed shall result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment.

Log required entries every two hours. Use the test report forms for logging the operational variables.

c. Notice of tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

d. Report forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment shall be reviewed, approved, and signed by the Contractor's test director. The manufacturer's field test representative shall review, approve, and sign the report of the manufacturer's recommended test. Signatures shall be accompanied by the person's name typed.

e. Deficiency resolution: The test requirements acceptably met; deficiencies identified during the tests shall be corrected in compliance with the manufacturer's recommendations and corrections retested in order to verify compliance.

3.5 SYSTEM PERFORMANCE TESTS

3.5.1 General Requirements

Before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. Field tests shall be coordinated with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING.

3.5.2 Test Report

The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

a. Date and outside weather conditions.

b. The load on the system based on the following:

(1) The refrigerant used in the system.
(2) Condensing temperature and pressure.
(3) Suction temperature and pressure.
(4) Running current, voltage and proper phase sequence for each phase of all motors.
(5) The actual on-site setting of all operating and safety controls.
(6) Chilled water pressure, flow and temperature in and out of the chiller.

3.6 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 4 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

-- End of Section --

SECTION 23 76 00.00 10

EVAPORATIVE COOLING SYSTEMS
04/08

PART 1 GENERAL

1.1 REFERENCES

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

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 210	(2007) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 410	(2001; Addendum 2002) Standard for Forced-Circulation Air-Cooling and Air-Heating Coils

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(1990; R 1999) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; R 2000) Load Ratings and Fatigue Life for Ball Bearings

ASTM INTERNATIONAL (ASTM)

ASTM A 1011/A 1011M	(2009b) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 176	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 924/A 924M	(2009a) Standard Specification for General

	Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 209	(2007) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 696	(2000; R 2009) Standard Specification for Coatings of Cadmium Mechanically Deposited
ASTM E 2016	(2006) Standard Specification for Industrial Woven Wire Cloth

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2007; Errata 2008) Standard for Motors and Generators

UNDERWRITERS LABORATORIES (UL)

UL 507	(1999; Rev thru Apr 2007) Electric Fans
UL 746C	(2004; Rev thru Sep 2009) Polymeric Materials - Use in Electrical Equipment Evaluations

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Evaporative Cooling Systems; G
Installation Drawings; G

Drawings consisting of layout of equipment including assembly and installation details and electrical connection diagrams. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function system as a unit and showing equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-03 Product Data

Equipment; G

Manufacturer's catalog data included with the detail drawings. Highlight the data to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

a. Evaporative coolers

Test Procedures; G

Proposed test procedures for performance tests of systems, at least 2 weeks prior to the start of related testing.

Installation; G

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

Manufacturer's Representative

A letter, at least 2 weeks prior to the start of work, listing the experience and training of the Manufacturer's Representative.

Service Organization

A letter, at least 2 weeks prior to the start of work, listing the experience and training of the Service Organization.

Performance Tests

Proposed test schedules for performance tests, at least 2 weeks prior to the start of related testing.

Training Course

Proposed schedule for field training submitted at least 2 weeks prior to the start of related training.

SD-06 Test Reports

Testing, Adjusting, and Balancing; G

Test reports for the performance tests in booklet form, upon completion of testing. Document in the reports all phases of tests performed including initial test summary, all repairs/adjustments made, and final test results.

SD-07 Certificates

Installation Drawings

Concurrent with installation drawings, manufacturer's certification of installation drawings.

SD-10 Operation and Maintenance Data

Evaporative Cooling Systems; G

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, cleaning, and routine maintenance, at least 2 weeks prior to field training. Include in the manuals the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and Service

Organization (including address and telephone number) for each item of equipment.

1.3 QUALITY ASSURANCE

1.3.1 Coordination of Trades

Furnish supports, piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction.

1.3.2 Manufacturer's Representative

Perform the work specified in this section under the supervision of and certified by the Manufacturer's Representative. Provide certification for installation drawings, test procedures, and test results. The Manufacturer's Representative shall have no less than 15 continuous years of experience directly involved in the design and installation of evaporative cooling systems, and have served in a similar capacity on no fewer than 100 projects of similar size and scope during that period.

1.3.3 Service Organization

Perform work specified in this section by a service organization certified by the System Manufacturer. The Service Organization shall have no less than 3 continuous years of experience directly involved in the installation, maintenance, and repair of evaporative cooling systems, and have served in a similar capacity on no fewer than five projects of similar size and scope during that period. The Service Organization submitted shall be capable of performing all maintenance and field repairs and providing 4 hour onsite response to a service call on an emergency basis.

1.3.4 SEISMIC PERFORMANCE REQUIREMENTS

A. Air handling unit unit manufacturer shall be be certified to design and build equipment to meet the requirements of ASCE-7 as referenced in the IBC, IBC 2003 and IBC 2006 codes as well as other state codes such as the California Building Code and OSHPD's current Code Application Notice dated October 31, 2008.

B. Certification of the air handling equipment shall be through engineering analysos performed by an independent consultant utilizing registered professional engineers specializing in seismic analysis. The analysis performed shall include structural calculations, static and dynamic finite element analysis and shake table testing. All analysis and testing shall be in accordance with ASCE-7 and ICC-ES AC156.

C. Manufacturer shall review the construction project Seismic Design Data or structural engineer's notes to determine if the equipment to be supplied will withstand the required seismic acceleration for that site and mounting.

D. A copy of the Seismic Certification Report and Certificate of Compliance shall be provided to the engineer for review and approval. The Certificate of Compliance shall also be submitted to the code enforcement official for review and acceptance.

E. Unit shall be provided with IBC compliant labeling and a Certificate of Compliance.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.5 EXTRA MATERIALS

Provide one set of spare parts and drive belts.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide an evaporative cooling systems designed and assembled by a manufacturer regularly engaged in the manufacturing of systems that are of a similar design, workmanship, capacity, and operation. Systems of similar design and capacity shall have been in satisfactory commercial or industrial use for 20 years before bid opening. The 20 years must be satisfactorily completed by a system which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Systems having less than a 20-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The system shall be supported by a service organization certified by the system manufacturer.

2.1.2 Asbestos Prohibition

Asbestos and asbestos-containing products will not be accepted.

2.1.3 Nameplates

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.1.4 Equipment Guards and Access

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

2.2 PIPING COMPONENTS

Piping components shall be as specified in Section 23 05 15 COMMON PIPING FOR HVAC.

2.3 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST

All ductwork and related accessories,shall be as specified in Section 23 00 00 AIR-SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

2.4 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with

motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring, shall be according to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical characteristics and enclosure type shall be as shown. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Adjustable frequency drives shall be used.

2.5 MISCELLANEOUS MATERIALS

Materials shall conform to the following:

2.5.1 Aluminum Sheets

ASTM B 209, Alloy 3003, temper H14.

2.5.2 Steel Sheets, Galvanized

ASTM A 924/A 924M, commercial quality.

2.5.3 Steel Sheets, Uncoated

ASTM A 1011/A 1011M, hot-rolled, commercial quality.

2.5.4 Structural Steel

ASTM A 36/A 36M.

2.5.5 Stainless Steel

ASTM A 167 and ASTM A 176.

2.6 EVAPORATIVE COOLERS

Units shall be a self-contained indirect/direct multi-stage, weather resistant drip, type, draw through and shall conform to UL 507 and UL 746C. Unit shall be the vertical downblast discharge type as indicated.

2.6.1 Fan Unit

The unit shall be the centrifugal type and shall be complete with motor, drive equipment, and spring vibration-isolation supports between motor and fan housing. Water distributor shall be separately controlled. Fan wheel shall be constructed of extruded aluminum. Bearings shall be precision self-aligning roller or ball-type with accessible grease fittings. Variable frequency drivers shall be mounted remote to evaporative coolers. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall beL10 rated at not less than 200,000 hours as defined by ABMA 9 and ABMA 11.

2.6.1.1 Fan Rating

Evaporative cooler fans shall have air delivery ratings based on AMCA 210 tests by an AMCA approved laboratory.

2.6.1.2 Retarding Agent

An ultraviolet retarding agent such as additives, gel coatings or other manufacturer approved equivalents shall be part of or applied on exterior nonmetallic components susceptible to ultraviolet degradation from sun rays and shall conform to UL 746C.

2.6.2 Evaporative Media

2.6.2.1 Evaporative Media

Media shall be fabricated of bonded synthetic fiber. Media shall be of the type specifically manufactured for use with evaporative coolers. Nonferrous metal media shall be constructed of corrosion and fungus resistant material not susceptible to decomposition by fungal or bacterial action. Media-pad face velocities shall not exceed500 FPM. Media shall be securely mounted in a stainless steel frame. Louvers shall be positioned in such manner that the water will not run on the outside surface. Nonrigid filter media shall be held in frame by a rigid retainer grid.

2.6.3 Water Handling Equipment

2.6.3.1 Water Handling Equipment for Drip Coolers

Water handling equipment shall thoroughly wet and continuously flush evaporative surfaces of the media material. The water distribution system shall be designed, to provide equal flow of water directly to the pads or to each trough. Troughs, if used, shall be stainless steel, designed in a manner that will effectively regulate the flow of water to the media pad to obtain even and complete saturation. Troughs shall be adjustable for leveling or sectionalized and each section supplied with water by means of an individual tube. The water pump shall be a centrifugal type with capacity and head characteristics for the specified operation of the unit and shall be provided with a low water safety shut-off. The motor shaft shall be constructed of stainless steel, hot-dip galvanized steel or cadmium coated steel. The impeller shall be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing shall be constructed of brass, conforming to UL 746C. Pump housing bottom shall be removable for impeller cleaning and shall not permit galvanic action with cooler bottom. Pump shall have permanently sealed and lubricated bearings and fan cooled motor with moisture proof winding. Pump motor shall be provided with a factory installed three conductor rubber sheathed flexible cord with the third wire being the grounding conductor. Water pump shall be provided with a filter screen constructed of plastic or bronze which shall project 1 inch above the high water level of the water tank.

2.6.3.2 Water Blowdown Equipment

Flush cycle water shall be automatically periodically dumped (approximately every six to twelve hours). This shall be done by either the use of a mechanical timer or by measuring the conductivity and dumping the water when the conductivity reaches 1500-2000 micro mhos.

2.6.4 Indirect Cooler Section

The indirect cooler shall consist of a non-clog min 1" square tube water-to-air heat exchanger, water distribution header, scavenger fan and motor, and recirculating water pump, cooling coil,heating coil, drain,

overflow and makeup water.

2.6.4.1 Heat Exchanger

The unit and all surfaces exposed to water shall be constructed of stainless steel. The plates shall be constructed in such a way as to withstand a 1 inch water gauge differential pressure without collapsing the plates. The unit must be at least 80 percent efficient. For cleaning purposes coils on finned tube water-to-air heat exchangers shall be plugged at the return bins.

2.6.4.2 Water Distribution Header

The water distribution header shall be a nonwettable, nondrip type. Water shall be distributed by means of copper spray headers with brass nozzles, or PVC header and nozzles, which shall impart a fine water mist into the scavenger air side of the heat exchanger.

2.6.4.3 Scavenger Fan

The fan shall be t axial type and shall be complete with motor, drive equipment, and vibration-isolation supports between motor and fan housing on single-phase motors. The fan motor shall be controlled by the HVAC system controls. Water distributor motor shall be synchronized to start and stop with the scavenger fan unit. Manual or automatic reset type thermal overload protection shall be provided in the starter or shall be integral with the motor. Motor starters shall be magnetic across-the-line type with weather resistant enclosure. Wheel shall be constructed of aluminum or stainless steel hot-dip zinc coated steel or cadmium coated steel shaft. Fans shall have an air delivery rating based on AMCA 210 tests by an AMCA approved laboratory.

2.6.4.4 Water Pump

The water pump shall be a self-priming centrifugal type with capacity and head characteristics for the specified operation of the unit. The motor shaft shall be constructed of stainless steel, cadmium coated steel or hot-dip zinc galvanized steel. The impeller shall be constructed of stainless steel or polymeric material conforming to UL 746C. Pump housing shall be constructed of factory hot-dip zinc coated steel or polymeric material conforming to UL 746C. Pump housing bottom shall be removable for impeller cleaning and shall not permit galvanic action with cooler bottom. Pump shall have permanently sealed and lubricated bearings and fan cooled motor with moisture proof winding. Pump motor shall be provided with a factory installed three conductor rubber sheathed flexible cord with the third wire being the grounding conductor. Water pump shall be provided with a filter screen constructed of plastic which shall project 1 inch above the high water level of the water tank.

2.6.5 Cooling Coil

Supplemental water cooling coil shall be located upstream from the direct stage. The coil shall be fin-and-tube type constructed of seamless copper tubes and copper or aluminum fins mechanically bonded or soldered to tubes. Headers shall be constructed of cast iron, welded steel or copper. Casing and tube support sheets shall be 16 gauge galvanized steel, formed to provide structural strength. Tubes shall be correctly circuited for proper water velocity without excessive pressure drop and they shall be drainable where required or indicated. Each coil shall be factory tested at not less

than 250 psi air pressure and shall be suitable for 200 psi working pressure. Drainable coils shall be installed in the units with a pitch of not less than 1/8 inch per foot of tube length toward the drain end. Coils shall conform to the provisions of AHRI 410.

2.7 CABINETS

Painted galvanized steel sheets or stainless steel shall be used in the construction of cabinets. Outside air inlets shall be protected with bird screens that conform to ASTM E 2016, Type I, Class 1, 2 by 2 mesh, 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire. Cabinets shall provide access to all moving parts including fans, pumps, and float valves.

2.7.1 Metal Cabinets

Cabinets shall be factory assembled by either welded or bolted and screwed construction. Cabinets shall be braced and reinforced. Bolts, screws, hinges, trim, and other metal appurtenances shall be cadmium plated or galvanized in accordance with ASTM B 696 or ASTM A 123/A 123M. When it is necessary to ship the unit disassembled, the cabinet sections shall be designed for assembly with cadmium plated or galvanized bolts. The interior and exterior of the galvanized steel cabinet, including hinges, handles, and other trim, shall be cleaned and chemically treated to assure paint adhesion. The interior bottom of cabinet shall bestainless steel. All water contact surfaces shall be constructed of 304 stainless steel. Cabinet construction for galvanized parts shall be 16 gauge minimum. 18 gauge minimum for stainless steel parts. Galvanized surfaces damaged during fabrication or handling shall be given a coat of zinc-rich paint. Finish shall be as specified in paragraph PAINTING AND FINISHING. Gauge of cabinet components shall be as indicated in TABLES I and II.

* In accordance with manufacturer's standards.

2.7.2 Polymeric Material Cabinets

Unit cabinets shall be constructed of polymeric materials, such as fiberglass or polypropylene and shall meet the requirements of UL 746C, Figure 12.1.

2.8 PREVENTION OF GALVANIC CORROSION

Materials that will be exposed to water during operation of the unit shall be such that galvanic action will not occur in the normal operation of the equipment. The cabinet and the exterior of the fan housing shall be finished with an enamel paint coat or epoxy coating. There will be no evidence of holidays and particular attention will be given to sealing joints. Media retainer will not be coated.

2.9 CONTROLS

Controls shall be as specified in Section 23 09 23.13 20 BACNET DIRECT DIGITAL CONTROL FOR HVAC.

2.10 FACTORY COATING

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish except water contact surfaces components inside and outside of the evaporative cooling

unit shall be stainless steel.

2.11 DAMPERS & LOUVERS

Dampers shall be supplied with low leak extruded aluminum airfoil blades. Blades shall be supplied with rubber edge seals and stainless seal arc end seals. Rubber edge seals shall be backed by the damper blade to assure a positive seal in the close position. Damper shall be provided with nylon bearings within extruded openings. Damper leakage shall not exceed 6 CFM/ft2 at 5.0" of static pressure. Leakage testing shall be in accordance with AMCA standard 500 figure 5.5. Test results must be from independent testing laboratory. Provide louvers for outside air and exhaust air for units located outdoors. OSA Louvers shall be sized for a miximum phase velocity of 500 ftm and exhaust air louvers shall be sized for a maximum phase velocity of 800 fpm based on gross louver area. Louvers shall have zero water penetration at 600-ft/min air velocity. Maximum louver pressure drop shall be 0.03" in w.g. at 500 ft/min. Provide test results from independent testing laboratory. Test must be conducted in accordance to AMCA Standard 500 figure 5.5. Louver water carry over must be less than 0.01 oz/ft2 at 1100 ft/min of free louver area. Test must be conducted by independent testing laboratory per AMCA 500-89 figure 5.6. Hoods in lieu of louvers are not acceptable.

2.11.1 ECONOMIZER/MIXING BOX

Economizer section shall include dampers for return air, fresh air and exhaust air. Dampers shall be opposed blade type. Dampers shall be sized for not greater than 1200 fpm phase velocity based upon gross damper area. Damper shall meet above specifications. Furnish full height 24" wide access doors for damper and linkage service.

2.12 Variable Frequency Drive

Furnish complete variable frequency VFDs as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 3R enclosure. The VFDs UL listing shall allow mounting in plenum or other air handing compartments.

All VFDs shall be provided with NEMA 3r enclosures complete with internal heaters, air filters and rain hoods.

The VFD and options shall be tested to ANSI/UL standard 508. The coomplete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate UL stickers shall be applied to both VFD and option panel, in the case where these are not contained in one panel. When these VFDs are to be located in Canada, CSA or C-UL certifications shall apply. Both VFD and option panel shall be manufactured in ISO 9001 certified facilities. VFD and bypass shall carry additional UL label indicating compliance with NEC requirements for 100,000 AMP short circuit capacity rating.

The VFD and any optional panels of any type (bypass etc.), shall be shown to be in compliance with the seismic requirements of section 1613 of the California Building Code (CBC) 2007 and ASCS 7-05. Compliance documentation shall be included as part of the equipment submittal.

The VFD shall 5% DC link reactors on both the positive and negative rails DC bus to minimize power line harmonics. VFDs without DC link reactor shall provide a minimum 5% impedence line reactor.

An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor speed and load and adjust the applied voltage to maximize energy savings and provide up to an sdditional 3% to 10% energy savings.

VFD shall minimize the audible motor noise throught the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.

The following interface features shall be included:

a. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.

b. The key pads for all sizes of VFDs shall be indentical and interchangeable.

c. To setup multiple VFDs, it shall be possible to upload all setup parimeters to the VFDs keypad, place that keypad on all other VFDs in turn and download the setup parimeters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parimeters.

d. The VFD shall include a standard EIA-485 communications port and capabilities to be connected to Siemens "Apogee" FLN ssystem at no additional cost the owner. The connection shall be software selectable by the user.

e. Additonally an optional communication card allowing use of BACNET or LonWorks shall be available.

f. The VFD shall full Serial Communications with the DDC/BAS (Direct Digital Control/Building Automation System) to allow for reviewing, changing and controlling VFD configuration and parameters. If serial communications is not provided, hand wiring is required all (8) digital inputs,(3) analog inputs,(2) digital outputs and (2) analog outputs on the VFD, as selected by the owner engineer and BAS/DDC installing company.

g. A three-feet back PID controller to control the speed of the VFD shall be standard.

1. The controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

2. The VFD shall be able to apply individual scaling to each feedback signal.

3. For fan flow tracking application, the VFD shall be able to

calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure airflow.

4. The VFDs PID controller shall be able to actively adjust its setpoint based on the flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.

If the temperature of the VFD heat sink rises to 80 degrees C, the VFD shall automatically reduces its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.

Standard programmable fire fighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in fire fighter's override mode. Fire mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accomodate local fire codes, standards and conditions.

A real-time clock shall be integral part of the VFD.

It shall be possible to use this to display the current date and time on the VFD display.

Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop fucntions, constant speeds, PID parameters setpoints and output relays. It shall be possible to program unique events that occur only during normal work days, others that occur only on non-workdays, and others that occur on specific days or dates. The manufacturer shall provide free PC based software to setup the calendar for the schedule.

All VFD faults shall be time stamped to aid troubleshooting.

It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

Provide a manaul three-contactor bypass consisting of a door interlock main fuse disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed Electronic or two-contactor bypass systems are not acceptable.

The manufacturer shall provide start-up commissioning of the VFD and its

optional circuits by a factory certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up shall include checking for verification of proper operation and installtion for the VFD, its options and its interface wiring to the building automation system.

The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

2.13 Air Flow Measuring Stations

Fans shall be supplied with the complete flow measuring system capable of supplying a 4-20mA. Output signal to the EMS system that is proportional to airflow.

1. The flow measuring station and a flow transmitter shall be factory mounted. The flow measuring station shall consist of pressure taps pick-ups located in the inlet cone of each fan. There shall be no obstruction created on the inlet of the fan by installation of flow measuring device. Flow measuring stations installed in the inlet of fan will obstruct the fan inlet and will decrease an efficiency and increase sound power levels. Provide a gauge with CFM scale on external side of the fan sections, which indicates the fan volume.

2. The electronic flow transmitter shall be mounted on the exterior of the fan section. It shall be capable of receiving signals of total and static pressure from a flow element and converting this pressure signal to produce a 4 - 20mA or 0 - 5 VDC output signal. The controls contractor shall convert the signal to achieve an air flow reading by use of the flow algorithm with this AHU manufacturer shall provide.

3. The tranmitter shall be a Setra model 264. The controls contractor shall provide the power for the transmitters.

2.14 Sound Power Levels

The maximum sound power level at the air handling unit discharge, return air inlet, fresh air inlet, and/or casing radiated shall not exceed the values given in the IDC on drawing schedule, when operating at a maximum design airflow and static pressure conditions.

Air handling unit sound power level data shall be submitted to the mechanical and acoustical engineers for approval. The submitted data shall be based on sound power measurements on similar units. The submittal shall include a complete description of the method and procedures used to develop the sound power levels being submitted and the submitted sound power level will be verified for a limited number of units described below by measurement of the sound power.

2.15 Sound Power and Performance Certification

The manufacture shall perform actual sound est on one selected AHU in accordance with AMCA standard 300-96 Reverberant Room Method for sound testing of fans, AMCA standard 210, Laboratoory Methods of Testing Fans for

Rating. All testing shall be conducted in a laboratory AMC certified for both sound and performance. The mechanical engineer shall selcet the test AHU after review of the submittal.

Air handling unit sound power data shall be submitted for review by owner's representative. Sound power data shall be given at the supply connection(s) (outlet) and return connection (s) (inlet) in addition to radiated sound power from the cabinet. Raw fan sound power data shall be derived from tests done in accordance with AMCA standard 300-96. Data extrapolated from non-like fan sizes and type schedule are not acceptable. Attenuation assumed for the cabinet configuration, type of isulation, opening location and sizes, etc., shall be verified through actual test measurements. The mechanical engineer may, at his option, request copies of such test.

The mechanical and acoustic engineers shall be allowed to witness the sound test. The AHU manufacturer shall notify the mechanical engineer a minimum of ten (10) days prior to test as to the location and date of the sound test. The travel cost incurred by test witnesses shall be borne by the equipment manufacturer.

If the sound test indicates AHU noise levels exceed levels of units specified, the contractor shall take corrective measures to reduce the sound. Any modifications that are necessary to meet scheduled sound levels shall be applied to all AHU's represented by the test unit. Test results shall be submitted to the owner's representative for approval prior to shipment of any equipment.

2.16 Air Performance Testing

The manufacture shall perform an air performance test on one selected unit in accordance to AMCA 210-85/ANSI 51-1985 "Standard For laboratory Measurement Of Air Flow." Air handling unit air performance data shall be submitted for review by owner's representative. The mechanical engineer shall be allowed to witness the air flow test. The AHU manufacturer shall notify the mechanical engineer a minimum of ten (10) days prior to test as to the location and date of the test. The travel cost incurred by test witnesses shall be borne by the equipment manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 INSTALLATION

Install all equipment as shown and in accordance with the manufacturer's diagrams and recommendations except where otherwise indicated. Connect units to the building's water supply system. Install a globe or gate valve and union in the water supply line adjacent to each unit. Valves shall not be installed with stems below the horizontal. Slope all supply piping to drain to the indicated stop and waste valve.

3.3 AIR-SUPPLY AND DISTRIBUTION SYSTEM

Install equipment, sheet metal work, air filters, and terminal units as specified in Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND

EXHAUST SYSTEM.

3.4 FIELD PAINTING AND FINISHING

Painting of surfaces not otherwise specified, including nonferrous metals, finish painting of items only primed at the factory, and field repair of factory finish, is specified in Section 09 90 00 PAINTING, GENERAL.

3.5 TRAINING COURSE

Conduct a training course for operating staff as designated by the Contracting Officer. The training period, for a total of 8 hours of normal working time, shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance instructions.

3.6 TESTING, ADJUSTING, AND BALANCING

Perform testing, adjusting, and balancing as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.7 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, the system shall be tested as a whole to see that all items perform as integral parts of the system and that operation is as specified. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by the Manufacturer's Representative. Tests shall cover a period of not less than 7 days and shall demonstrate that the entire system is functioning according to the specifications. Ambient air temperature and supply air temperature and quantity readings shall be made at hourly intervals for the duration of the time period.

3.8 CLEANING

Thoroughly clean ducts, plenums, and casings of all debris; blow them free of all small particles of rubbish and dust before installing outlet faces. Equipment shall be wiped clean, with all traces of oil dust, dirt, or paint spots removed. Provide temporary filters for all fans that are operated during construction; and after all construction dirt has been removed from the building, install new filters. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer.

-- End of Section --

SECTION 23 82 02.00 10

UNITARY HEATING AND COOLING EQUIPMENT
04/08

PART 1 GENERAL

1.1 REFERENCES

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 700	(2006; Addendum 1 2009) Specifications for Fluorocarbon Refrigerants
ANSI/AHRI 210/240	(2008) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment
ANSI/AHRI 340/360	(2007) Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ANSI/ASHRAE 15 & 34	(2007; Std 15 Errata 2007, 2009, & Addenda a-i; Std 34 Errata 2007, 2008, Addenda a-v, x-ae) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 52.1	(1992; Interpretation 1 2007) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

AMERICAN WELDING SOCIETY (AWS)

AWS Z49.1	(2005) Safety in Welding and Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(202010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A 307	(2007b) Standard Specification for Carbon

	Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM B 117	(2009) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM D 520	(2000; R 2005) Zinc Dust Pigment
ASTM E 84	(2010) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F 104	(2003) Standard Classification System for Nonmetallic Gasket Materials

UNDERWRITERS LABORATORIES (UL)

UL 1995	(2005; R 2009) Heating and Cooling Equipment
UL 586	(2009) Standard for High-Efficiency Particulate, Air Filter Units
UL 900	(2004; R 1995 thru 2009) Standard for Air Filter Units

1.2 SYSTEM DESCRIPTION

The variable capacity, heat recovery air conditioning system shall be a Daikin Variable Refrigerant Volume Series (heat and cool model) split system as specified. The system shall consist of multiple evaporators, branch selector boxes, REFNET (tm) joints and headers, a three pipe refrigeration distribution system using PID control, and Daikin VRV outdoor unit. The outdoor unit is a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioning system with variable speed driven compressors using R-410A refrigerant. The outdoor unit may connect and indoor evaporator capacity up to 200% of the outdoor condensing unit capacity. All zones are each capable of operating separately with individual temperature control. Two-pipe systems requiring separation of the gas and liquid refrigerant are not acceptable.

The Dailin outdoor unit shall be interconnected to indoor unit models FXAQ and shall range in capacity from 7500 BTU/H to 4800 BTU/H in accordance with Daikin's enginnering data book detailing each available indoor unit. The indoor units shall be connected to the outdoor utilizing Daikin REFNET specified piping joints and headers.

Opration of the system shall permit either individual cooling or heating of each fan coil simultaneoulsy or all of the fan coil units associated with one branch cool/heat selector box (BSVQ). Each fan coil or group of fan coil shall be able to provide set temperature independently via a local remote conroller and Intelligent Controller, and Intelligent Manager, or a BMS interface.

Branch selector (BS) boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control up to 60 MBH (cooling) downstream of the BS box. The BS box shall consist of five e;lectronic expansion valves, refrigerant control piping and electronics to facilitate communications between the BS box and main processor and between

the BS box and fan coils. The BS box shall control the operational mode of the subordinate fan coils. The use of five EEV's ensures continuous heating during defrost, no heating impact during changeover and reduce sound levels. Use of multi-port branch selector branches shall not be acceptable.

1.2.1 VRV III FEATURES AND BENEFITS

a. Voltage Platform - Heat pump heat recovery condensing units shall be available with a 208V/3/60 power supply.

b. Advanced Zoning - A single system shall provide for up to 41 zones.

c. Auto-charging - Each system shall have a refrigerant auto-charging function.

d. Charge Checking - Each system shall have a refrigerant charge checking function.

e. Defrost Heating - Each system shall maintain continuous heating during defrost operation.

f. Independent Control - Each fan coil shall use a dedicated electronic expansion valve for independent control.

g. VFD Inverter Control - Each condenisng unit shall use a high efficiency, variable speed "Inverter" compressor coupled with inverter fan motors for superior part load performance. Compressor capacity shall be modulated automatically to maintain a constant suction pressure, while varying the refrigerant volume for the needs to the cooling or heating loads. Indoor fan coil units shall use PID control to control superheat and maintain the temperature setpoint within +/- 1 degree F.

h. Flexible Design

1. System shall be capable of up to 540 ft (640 ft equivalenet)of linear piping between the condensing unit and furthest located fan coil unit.
2. Sytems shall be capable of up to 3,280 ft total "One-way" piping in the piping network.
3. Systems shall a vertical (height) separation of up to 295 ft between the condensing unit and the fan coil units.
4. Systems shall be capable of 290 ft from the first REFNET/branch point.
5. The outdoor unit shll connect an indoor evaporator capacity of up to 200% of the outdoor condensing unit capacity.
6. System shall be capable of 49 feet between fan coil units.
7. Condensing units shall be supported with a fan/fan motor ESP up to 0.32 inches WG as standard to allow connection of discharged ductwork and to prevent discharge air short circuiting.

i. Simple Wiring - System shall use 16 AWG, 2 wire, mutli-stranded, non-sheilded and non-polarized daisy chain control wiring.

j. Energy Efficiencny - System shall have equivalent or better performance than high efficiency air-colled or water cooled

chiller systems.

k. Advanced Diagnostics - Systems shall included a self diagnostic, auto-check function to detect a malfunction and display the type and location.

l. Advance Controls - Each system shall have at least one remote controller capable of controlling up to 16 fan coil units. Each system shall be capable of integrading with open protocol BACnet/IP building management systems.

m. Low Sound Levels - Each system shall use indoor and outdoor units with quiet operation as low as 25 dB(A).

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings

Drawings provided in adequate detail to demonstrate compliance with contract requirements, as specified.

SD-03 Product Data

Materials and Equipment

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.

Spare Parts

Spare parts data for each different item of equipment specified.

Posted Instructions

Posted instructions, at least 2 weeks prior to construction completion, including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions shall be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

Verification of Dimensions

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, confirmation of existing conditions, and any discrepancies found.

Coil Corrosion Protection

Product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement.

System Performance Tests

A schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules shall identify the proposed date, time, and location for each test.

Demonstrations; G

A schedule, at least 2 weeks prior to the date of the proposed training course, which identifies the date, time, and location for the training.

SD-06 Test Reports

Refrigerant Tests, Charging, and Start-Up; G

Six copies of each test containing the information described below in bound 8-1/2 by 11 inch booklets. Individual reports shall be submitted for the refrigerant system tests.

a. The date the tests were performed.
b. A list of equipment used, with calibration certifications.
c. Initial test summaries.
d. Repairs/adjustments performed.
e. Final test results.

System Performance Tests; G

Six copies of the report provided in bound 8-1/2 by 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system.

SD-07 Certificates

Materials and Equipment

Where the system, components, or equipment are specified to comply with requirements of AHRI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform

to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard AHRI rating conditions, computer printouts, catalog, or other application data certified by AHRI or a nationally recognized laboratory as described above shall be included. If AHRI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

Service Organization

A certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

Six complete copies of an operation manual in bound 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown at least 4 weeks prior to the first training course. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features. Six complete copies of maintenance manual in bound 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

1.4 QUALITY ASSURANCE

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Submit drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

h. The system must be installed by a Daikin factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements. Untrained contractors who wish to bid this project must contact Daikin to arrange training prior to bid day.

1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide Materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

2.1.2 Nameplates

Major equipment including compressors, condensers, receivers, heat

exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.1.3 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

2.2 UNITARY EQUIPMENT, SPLIT SYSTEM

Unit shall be an air-cooled, split system which employs a remote condensing unit, a separate indoor units, and interconnecting refrigerant piping. Unit shall be the heat pump type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with ANSI/AHRI 210/240or ANSI/AHRI 340/360as appropriated. Unit shall be provided with necessary fans, air filters, and cabinet construction as specified in paragraph "Unitary Equipment Components". The remote unit shall be as specified in paragraph REMOTE CONDENSER OR CONDENSING UNIT. Evaporator or supply fans shall be direct drive DC (ECM) type. Condenser or outdoor fans shall be propeller type. Fan and condenser motors shall have totally enclosed enclosures.

2.2.1 Air-to-Refrigerant Coil

Coils shall have copper tubes ofwith aluminum fins that are mechanically bonded or soldered to the tubes. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.3 REMOTE CONDENSER OR CONDENSING UNIT

The outdoor unit is designed specifically for use with VRV III series componets.

a. The outdoor unit shall factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of Daikin scroll compressors, motors, fans, condenser coil, electronic expansion valves, solanoid valves, 4-way valve, distribution headers, capilaries, filters, shut off valves, oil separators, service ports and refrigerants regulator. High/Low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.

b. The outdoor unit can be wired and piped with outdoor unit access from the left, right, near or bottom.

c. The connection ratio of indoor units to outdoor unit shall be permitted up to 200%.

d. Each outdoor system shall be able to support the connection of up to 41 indoor units dependent on the model of the outdoor unit.

e. The sound pressure level standard shall be that value as listed in the Dailin engineering manual for the specified models at 3 feet from the front of the unit. The outdoor unit shall be capable of operating autimatically at further reduced noise during night time.

f. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.

g. The unit shall incorporate an auto-charging feature and a refrigerant charge check function.

h. The outdoor unit shall be modular in design and should allow for side-by-side installtion with minimum spacing.

i. The following safety devices shall be included on the condensing unit; high pressure switch control circuit fuses, crank case heaters, fusable plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

j. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-colling feature.

k. Oil recovery cycle shall be automatic occuring 2 hour after start of operation and then every 8 hours of operation.

l. The outdoor unit shall be capable of heating operation at 0 degrees F dry bold ambient temperature without additional low ambient controls.

m. The system shall continue to provide heat to the indorr unit and heating operation while in defrost mode.

2.3.1 Unit Cabinet

The outdoor unit shall be completely weather proof and corrosion resistant. The uni shall be constructed from rust-proof mild steel panels coded with a baked enamel finish.

2.3.2 Fan

The condensing unit shall consist of one or more propeller type, direct-drive 350 and 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.

Model Numner	Fan Motor Output (W) & Quantity
REYQ192PYDN	750 x 2

Model Numner	Fan Motor Output (W) & Quantity
REYQ216PYDN	750 x 2
REYQ240PYDN	750 x 2

The condensing unit fan motor shall multiple speed operation of the DC and (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 inch WG. A field setting switch to a maximum 0.32 inch WG pressure is available to accomodate field applied duct for indoor mounting of condensing units.

The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 6700 CFM to 14120 CFM dependent on model specified.

Nominal sound pressure levels shall be as shown below.

Model Numner	Sound Pressure Level dB(A)
REYQ192PYDN	62
REYQ216PYDN	62
REYQ240PYDN	63

The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.

The fan motor shall be provided with a fan guard to prevent contact with moving parts.

Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.

Operation Sound (dB)	Night Mode Sound Pressure Level (dB)
Step 1 Max	55
Step 2 max	50
Step 3 Max	45

2.3.3 Condenser Coil

a. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.

b. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.

c. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.

d. The fins are to be covered within anti-corrossion acrylic resin and hydrophilic film type E1.

e. The pipe plates shall be treated with powdered polyester resin for corrossion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

2.3.4 Compressor

a. The Daikin inverter scroll compressor shall be variable speed controlled which in capable of changing the speed to follow the variations in total cooling and healing load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressure detective are read every 20 seconds and calculated. With each reading, the compressor capacity shall be controlled to eliminate deviation from target value.

b. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll "G-type" with a maximum speed of 6480 rpm.

c. Neodymium magnets shall be adopted in the motor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium manets will position the rotor into the optimum position for a low torque start.

d. The capacity control range shall be as low as 6% to 100%.

e. Each non-inverter compressor shall also be of the hermetically sealed scroll type.

f. Each compressor shall be equip with a crank case heater, high pressure safety swithc, and internal thermal overload protector.

g. Oil separators shall be standard with the equipment together with an intelligent oil management system.

h. The compressor shall be spring mounted to avoid the transmission of vibration.

i. Unit size 8-12 ton shall contain a minimum of 2 compressors; 14-16 ton unit shall contain a minimum of 3 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating and cooling as required at a proportionally reduced capacity. The micro compressor and associated controls shall be designed to specifically address this condition.

Tonnage	Number of Compressor	Compressor Types
16	3	(1 inverter+1 fixed) + 1 inverter
18	4	(1 inverter+1 fixed) x 2
20	4	(1 inverter+1 fixed) x 2

j. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, insuring sequential starting of each module at each start/stop cycle, comption of oil return, completion of defrost or every 8 hours.

2.3.5 Electrical

a. The power supply to the outdoor unit shall be 208 volts, 3 phase, 60 hertz +/- 10%.

b. The control voltage between the indoor and outdoor unit shall be 16 VDC non-shielded, stranded type 2 conductor cable.

c. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable wire, thus simplifying the witing operation.

d. The control wiring lights shall be as shown below.

	Outdoor to Indoor Unit	Outdoor to Central Controller	Indoor Unit to Remote Control
Control Wiring Length	6665 feet	3330 feet	1665 feet
Wire Type	16 AWG, 2 wire, non-polarity, non-shielded, stranded		

2.3.6 BSVQ Branch Selector Box for VRV III Heat Recovery System

2.3.6.1 General

The BSBQ36PVJU and BSVQ60PVJU branch selector boxes are designed specifically for use with VRV III series heat recovery system components.

a. These seletor boxes shall be factory assmebled, wired, and piped.
b. These BSVQ branch controllers must be run tested at the factory.
c. These selector boxes must be mounted indoors.
d. When simultaneously heating and cooling, the units in heating mode shall energized their sub-cooling solenoid valve.
e. The number of connectible indoor units shall be in accordance with the table below.

Model Number	Maximum Connectable Cooling Capacity	Maximum Number of Connectable Indoor Units
BSVQ36PVJU	36000 Btu/h	3
BSVQ60PVJU	60000 Btu/h	5

2.3.6.2 Unit Cabinet

These units shall have a galvanized steel plate casing. Each cabinet shall house multiple refrigeration control valves and a liquid gas separator. The cabinet shall contain a tube in tube heat exchanger. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethlylene.

Model Number	Sound Level dB(A) Operating	Sound Level dB(A) Stopping
BSVQ36PVJU	42	32
BSVQ60PVJU	43	32

2.3.6.3 Dimensions

Each BSVQ unit shall be no larger than 8-3/16 inch x 15-5/16 inch x 12-7/8 inch.

2.3.7 Refrigerant Valves

The unit shall be furnished with 5 electronic expansion valves to control the direction of refrigerant flow. Branch selector box design utilizing solenoid valves for control will not be acceptable.

The refrigerant connections must be of the braze type.

Each circuit shall have at least one (3600 Btu/h fan coil unit or smaller for the BSVQ36PVJU and 60000 Btu/h fan coil unit or smaller for the BSVQ60PVJU) branch selector box.

Multiple circuits maybe be connected to a branch selector box with the use of pre-engineered factory furnished copper piping joint kits ("REFNET (tm) joints).

2.3.8 Drainage

The unit shall not require any condensate drainage connection.

2.3.9 Electrical

The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.

The unit shall be capable of operation within the limits of 187 volts to 255 volts.

The minimum circuit amps (MCA) shall be 0.1 and the maximum fuse amps (MFA) shall be 15. Multiple Branch Selector Boxes may be connected to the same electrical power circuit or powered by the same electrical circuit as the fan coils.

The control voltage between the indoor and outdoor unit shall be 16VDC non-shielded 2 conductor cable.

2.4 EQUIPMENT EFFICIENCY

Unit shall have an efficiency as indicated on the drawings.

2.5 UNITARY EQUIPMENT COMPONENTS

2.5.1 Refrigerant and Oil

Refrigerant shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. Refrigerants shall meet the requirements of AHRI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of

less than or equal to 0.05. Provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

2.5.2 Air Filters

Air filters shall be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method shall be as listed under the label service and shall meet the requirements of UL 586.

2.5.2.1 Extended Surface Pleated Panel Filters

Filters shall be 2 inch depth sectional type of the size indicated and shall have an average efficiency of merv 13 when tested in accordance with ASHRAE 52.1. Initial resistance at 500 feet/minute will not exceed 0.36 inches water gauge. Filters shall be UL Class 2. Media shall be nonwoven cotton and synthetic fiber mat. A wire support grid bonded to the media shall be attached to a moisture resistant fiberboard frame. Four edges of the filter media shall be bonded to the inside of the frame to prevent air bypass and increase rigidity.

2.6 ACCESSORIES

2.6.1 Refrigerant Signs

2.6.1.1 BACnet Interface

a. BACnet interface unit shall be provided for BACnet over ethernet communication.

2.6.1.2 Installation Identification

Each new refrigeration system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.6.2 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.6.3 Bolts and Nuts

Bolts and nuts shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.6.4 Bird Screen

Screen shall be 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire.

2.7 FINISHES

2.7.1 Factory Coating

2.7.1.1 Equipment and Components

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.7.2 Factory Applied Insulation

Refrigeration equipment shall be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation shall be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

2.8 SUPPLEMENTAL COMPONENTS/SERVICES

2.8.1 Refrigerant Piping

Refrigerant piping for split-system unitary equipment shall be provided and installed in accordance with Section 23 23 00 REFRIGERANT PIPING.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

3.2 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1and ASME BPVC SEC IX, the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

3.2.1 Field Applied Insulation

Field applied insulation shall be as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.2 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4 DEMONSTRATIONS

Conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 8 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field posted instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations.

3.5 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems shall be tested and charged as specified in Section 23 23 00 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged shall be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems shall be tested for leaks with a halide torch or an electronic leak detector.

3.5.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant

be discharged into the atmosphere.

3.5.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

3.6 SYSTEM PERFORMANCE TESTS

Before each refrigeration system is accepted, conduct tests to demonstrate the general operating characteristics of all equipment by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and shall demonstrate that the entire system is functioning in accordance with the drawings and specifications. Make corrections and adjustments, as necessary, tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested. Tests shall be conducted in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Field tests shall be coordinated with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS. Submit a report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart):

a. Date and outside weather conditions.

b. The load on the system based on the following:

(1) The refrigerant used in the system.
(2) Condensing temperature and pressure.
(3) Suction temperature and pressure.
(4) Ambient, condensing and coolant temperatures.
(5) Running current, voltage and proper phase sequence for each phase of all motors.

c. The actual on-site setting of operating and safety controls.

d. Thermostatic expansion valve superheat - value as determined by field test.

e. Subcooling.

f. High and low refrigerant temperature switch set-points

g. Low oil pressure switch set-point.

h. Defrost system timer and thermostat set-points.

i. Moisture content.

j. Capacity control set-points.

k. Field data and adjustments which affect unit performance and energy consumption.

l. Field adjustments and settings which were not permanently marked as an integral part of a device.

-- End of Section --

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS
07/06

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM D 709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE C57.12.28	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

1.2 RELATED REQUIREMENTS

This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, of this project specification unless specified otherwise in the individual sections. This section has been incorporated into, and thus, does not apply to, and is not referenced in the following sections.

Section 26 12 19.10 THREE-PHASE PAD MOUNTED TRANSFORMERS
Section 26 20 00 INTERIROR DISTRIBUTION SYSTEM
Section 26 23 00 SWITCHBOARDS AND SWITCHGEAR
Section 26 51 00 INTERIOR LIGHTING
Section 26 56 00 EXTERIOR LIGHTING
Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 12.47 kV primary, three phase, three wire, 60 Hz, and 480/277 volts secondary, three phase, four wire. Final connections to the power distribution system at the existing substation shall be made by the Contractor as directed by the Contracting Officer.

1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.5.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

1.6.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.9 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.10 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.11 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers and pad-mounted SF6 switches, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.13 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day)

of instruction furnished shall be as specified in the individual section.

PART 2 PRODUCTS

2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

-- End of Section --

SECTION 26 05 00.00 40

COMMON WORK RESULTS FOR ELECTRICAL
11/08

PART 1 GENERAL

1.1 REFERENCES

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

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480	(1981) Toggle Switches

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1	(2003; R 2004) Standard for Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FB 1	(2007) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA OS 1	(2008) Standard for Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	(2006; Errata 2008) Standard for Panelboards
NEMA RN 1	(2005) Standard for Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC 3	(2004) Standard for Polyvinyl Chloride PVC Fittings for Use With Rigid PVC Conduit and Tubing

NEMA WD 1	(1999; R 2005) Standard for General Requirements for Wiring Devices
NEMA WD 6	(2002; R 2008) Standard for Wiring Devices - Dimensional Requirements
NEMA Z535.1	(2006) Standard for Safety Colors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Rev thru Jul 2007) Standard for Flexible Metal Conduit
UL 1242	(2006; Rev thru Jul 2007) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 489	(2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 506	(2008; Rev thru Dec 2009) Standard for Specialty Transformers
UL 6	(2007) Standard for Electrical Rigid Metal Conduit-Steel
UL 797	(2007) Standard for Electrical Metallic Tubing -- Steel
UL 870	(1995; Rev thru Jul 2003) Standard for Wireways, Auxiliary Gutters, and Associated Fittings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Conduits, Raceway sand Fittings; G
Wire and Cable; G
Splices and Connectors; G
Switches; G
Receptacles; G
Outlets, Outlet Boxes, and Pull Boxes; G
Circuit Breakers; G
Lamps and Lighting Fixtures; G

Spare Parts; G

SD-08 Manufacturer's Instructions

Submit Manufacturer's Instructions.

1.3 PREVENTION OF CORROSION

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09 90 00 PAINTS AND COATINGS. Do not use aluminum when in contact with earth or concrete and, where connected to dissimilar metal, protect by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

1.4 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

1.5 GENERAL REQUIREMENTS

Submit Material, Equipment, and Fixture Lists for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Submit Manufacturer's Instructions including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

2.1.1 Rigid Steel Conduit

Rigid steel conduit shall comply with UL 6 and be galvanized by the hot-dip process. Rigid steel conduit shall be polyvinylchloride (PVC) coated in accordance with NEMA RN 1, where underground and in corrosive areas, or must be painted with bitumastic.

Fittings for rigid steel conduit shall be threaded.

Gaskets shall be solid. Conduit fittings with blank covers shall have

gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers shall have captive screws and be accessible after the work has been completed.

2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be in accordance with UL 797 and be zinc coated steel. Couplings and connectors shall be zinc-coated, raintight, gland compression with insulation throat. Crimp, spring, or setscrew type fittings are not acceptable.

2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall comply with UL 1 and be galvanized steel.

Fittings for flexible metallic conduit shall be specifically designed for such conduit.

Provide liquidtight flexible metallic conduit with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Specifically design fittings for liquidtight flexible metallic conduit for such conduit.

2.1.4 Intermediate Metal Conduit

Intermediate metal conduit shall comply with UL 1242 and be galvanized.

2.1.5 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall comply with NEMA TC 2 and NEMA TC 3 with wall thickness not less than Schedule 40.

2.1.6 Wireways and Auxiliary Gutters

Wireway and auxiliary gutters shall be a minimum 4- by 4 inch trade size conforming to UL 870.

2.1.7 Surface Raceways and Assemblies

Surface metal raceways and multi-outlet assemblies shall conform to NFPA 70. Receptacles shall conform to NEMA WD 1, Type 5-20R.

2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type THHN. All conductors AWG No. 8 and larger, shall be stranded. All conductors smaller than AWG No. 8 shall be stranded.

Flexible cable shall be Type SO and contain a grounding conductor with green insulation.

Conductors installed in plenums shall be marked plenum rated.

2.3 SPLICES AND CONNECTORS

Make all splices in AWG No. 8 and smaller with approved indentor crimp-type connectors and compression tools.

Make all splices in AWG No. 6 and larger with bolted clamp-type connectors. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

2.4 SWITCHES

2.4.1 Safety Switches

Safety switches shall comply with NEMA KS 1, and be the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, when the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and be so constructed that an external tool shall be used to open the cover. Make provisions to lock the handle in the "OFF" position, but the switch shall not be capable of being locked in the "ON" position.

Provide switches of the quick-make, quick-break type. Approve terminal lugs for use with copper conductors.

Safety color coding for identification of safety switches shall conform to NEMA Z535.1.

2.4.2 Toggle Switches

Toggle switches shall comply with EIA 480, control incandescent, mercury, and fluorescent lighting fixtures and be of the heavy duty, general purpose, noninterchangeable flush-type.

Toggle switches shall be commercial grade toggle type, single -pole, three -way two-position devices rated 20 amperes at 277 volts, 60 hertz alternating current (ac) only.

All toggle switches shall be products of the same manufacturer.

2.5 RECEPTACLES

Receptacles shall be commercial grade, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6, NEMA 5-20R.

2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

Outlet boxes for use with conduit systems shall be in accordance with NEMA FB 1 and NEMA OS 1 and be not less than 1-1/2 inches deep. Furnish all pull and junction boxes with screw-fastened covers.

2.7 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be the circuit-breaker type in accordance with NEMA PB 1. Bolt circuit breakers to the bus. Plug-in circuit breakers are not acceptable. Buses shall be copper of the rating indicated, with main lugs or main circuit breaker as indicated. Provide all panelboards for use on grounded ac systems with a full-capacity isolated neutral bus and a separate grounding bus bonded to

the panelboard enclosure. Panelboard enclosures shall be NEMA 250, Type 1, in accordance with NEMA PB 1. Provide enclosure fronts with latchable hinged doors.

2.8 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be not less than those indicated and in no event less than 10,000 amperes root-mean-square (rms) symmetrical at 208 volts, respectively. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit breakers shall be bolt-on type conforming to UL 489.

2.9 LAMPS AND LIGHTING FIXTURES

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, are acceptable. Provide lamps of the proper type and wattage for each fixture.

2.10 DRY-TYPE DISTRIBUTION TRANSFORMERS

General purpose dry-type transformers with windings 600 volts or less shall have copper windings and be two-winding, 60 hertz, self-cooled in accordance with UL 506. Windings shall have a minimum of two 2-1/2-percent taps above and below nominal voltage.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clear any clogged conduit of obstructions or be replaced.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

3.1.1 Rigid Steel Conduit

Make field-made bends and offsets with approved hickey or conduit bending machine. Conduit elbows larger than 2-1/2 inches shall be long radius.

Provide all conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, with a flush coupling when the floor slab is of sufficient thickness. Otherwise,provide a floor box set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.1.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

3.1.3 Flexible Metallic Conduit

Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Bonding wires shall be used in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit shall not be considered a ground conductor.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit.

Liquidtight flexible metallic conduit shall be used in wet and oily locations and to complete the connection to motor-driven equipment.

3.1.4 Intermediate Conduit

Make all field-made bends and offsets with approved hickey or conduit bending machine. Use intermediate metal conduit only for indoor installations.

3.1.5 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be direct buried.

A green insulated copper grounding conductor shall be in conduit with conductors and be solidly connected to ground at each end. Grounding wires shall be sized in accordance with NFPA 70.

3.1.6 Surface Raceways and Assemblies

Surface raceways shall be mounted plumb and level, with the base and cover secured. Minimum circuit run shall be three-wire with one wire designated as ground.

3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows for 208/120 volt three-phase:

CONDUCTOR	COLOR AC
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Equipment Grounds	Green

Conductors up to and including AWG No. 2 shall be manufactured with colored insulating materials. Conductors larger than AWG No. 2 shall have ends

identified with color plastic tape in outlet, pull, or junction boxes.

Splice in accordance with the NFPA 70. Provide conductor identification within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match as indicated.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.3 SAFETY SWITCHES

Securely fasten switches to the supporting structure or wall, utilizing a minimum of four 1/4 inch bolts. Do not use sheet metal screws and small machine screws for mounting. Do not mount switches in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 4 feet above floor level, when possible.

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

Install wall switches and receptacles so that when device plates are applied, the plates will be aligned vertically to within 1/8 inch.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Required marking shall consist of a self-adhesive label having 1/4 inch embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

3.5 BOXES AND FITTINGS

Furnish and install pullboxes where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Securely mount boxes and enclosures to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be in accordance with ICC A117.1 and as follows:

LOCATION	MOUNTING HEIGHT
Receptacles in offices	18 inches (to center)
Receptacles in corridors	18 inches (to center)
Receptacles in shops & laboratories	48 inches (to top)
Receptacles in rest rooms	48 inches (to top)
Switches for light control	48 inches (to top)

3.6 LAMPS AND LIGHTING FIXTURES

Install new lamps of the proper type and wattage in each fixture. Securely fasten fixtures and supports to structural members and install parallel and perpendicular to major axes of structures.

3.7 PANELBOARDS

Securely mount panelboards so that the top operating handle does not exceed 72-inches above the finished floor. Do not mount equipment within 36 inches of the front of the panel. Directory card information shall be complete and legible.

3.8 DRY-TYPE DISTRIBUTION TRANSFORMERS

Connect dry-type transformers with flexible metallic conduit.

3.9 IDENTIFICATION PLATES AND WARNINGS

Furnish and install identification plates for lighting and power panelboards, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Control devices and pilot lights shall have identification plates.

Furnish identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

3.10 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall be thoroughly cleaned and painted as specified in Section 09 90 00 PAINTS AND COATINGS.

3.11 FIELD TESTING

Submit Test Reports in accordance with referenced standards in this section.

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Contractor shall provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Perform Insulation-Resistance Test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values shall not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes 8AWG and smaller insulation resistance testing is not required.

Perform Continuity Test to insure correct cable connection (i.e correct phase conductor, grounded conductor, and grounding conductor wiring) end-to end. Any damages to existing or new electrical equipment resulting from contractor mis-wiring will be repaired and re-verified at contractor's expense. All repairs shall be approved by the CO prior to acceptance of the repair.

Conduct Phase-Rotation Tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the CO.

-- End of Section --

SECTION 26 05 13.00 40

MEDIUM-VOLTAGE CABLES
11/08

PART 1 GENERAL

1.1 REFERENCES

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

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC C8	(2000) Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV
AEIC CS1	(1990e11) Impregnated-Paper-Insulated, Metallic Sheathed Cable, Solid Type

ASTM INTERNATIONAL (ASTM)

ASTM B 3	(2001; R 2007) Standard Specification for Soft or Annealed Copper Wire
ASTM D 746	(2007) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 400.2	(2004) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 70	(2009) Standard for Non-Shielded Power Cable 2000 V or Less for the Distribution of Electrical Energy
NEMA WC 71	(1999) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy
NEMA WC 74	(2006) Standard for 5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electric Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

1.2 DEFINITIONS

Medium voltage power cables includes all cables rated above 600 to 35,000

volts.

1.3 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Provide Certificates for the following showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Provide certified copies of test data that shows conformance with the referenced standards and is approved prior to delivery of cable.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Provide equipment and performance data and manufacturer's catalog data for the following items:

Single-Conductor Shielded Cables; G

SD-08 Manufacturer's Instructions

Provide manufacturer's instructions showing the recommended sequence and method of installation for the following:

Medium-Voltage Power Cables; G

1.5 QUALIFICATIONS

Cable splicers performing splicing are required to have 5 years experience in cable splicing and terminations. Once a termination or splice has been started by a worker, the same person completes that particular splice. Start and complete each termination and splice in one continuous work period.

1.6 CABLE VOLTAGE RATINGS

Provide Medium-voltage power cablessingle-conductor cables rated as follows, phase-to-phase, for grounded and ungrounded neutral systems:

Use cables rated 15,000 volts, ungrounded neutral, on 12,470-volt, three-phase, 60-hertz distribution systems.

1.7 SHIPMENT

Ship cables on reels such that the cable is protected from mechanical injury. Hermetically seal and securely attach each end of each length of cable to the reel.

Make minimum reel drum diameter 14 times the overall diameter of the cable. Provide a pulling eye that is installed by the manufacturer for each length of cable supplied for installation in ducts, manholes, and utility tunnels.

PART 2 PRODUCTS

2.1 CONDUCTORS

Provide conductors that are solid copper conforming to ASTM B 3.

2.2 CABLE IDENTIFICATION

Provide cables that have a tape placed immediately under the lead sheath or outer jacket showing the name of the manufacturer, the year in which the cable was manufactured, and a unique number for identification purposes. Closely group information on the tape at 1-foot intervals to permit complete identification.

2.3 SINGLE-CONDUCTOR SHIELDED CABLES

2.3.1 Ethylene-Propylene-Rubber-Insulated with PVC Jacket

Provide single-conductor 15 KV cable assemblies that consist of: Class B stranded copper conductors, an extruded semiconducting shield over the conductors, 220 mils of ethylene propylene rubber insulation, an extruded or other approved semiconducting shield, a 5 mil minimum copper tape shield wrapped helically with a minimum 25 percent overlap and a PVC jacket.

Provide single-conductor, ethylene-propylene-insulated, polyvinylchloride-jacketed, shielded cable that conforms to NEMA WC 70, NEMA WC 71, NEMA WC 74 and AEIC C8.

2.4 CABLE SUPPORTS AND FITTINGS

Provide cable supports, related fittings, and accessories for use in corrosive underground locations, such as manholes and utility tunnels, with a factory applied coating of polyvinylchloride of at least 20 mils thick. Provide polyvinylchloride (PVC) coated items that have a uniform thickness and be free of blisters, breaks, and holidays. Provide PVC compound that conforms to ASTM D 746.

Provide cable racks, cable tray supports and related fittings that are UL listed heavy-duty nonmetallic polycarbonate.

PART 3 EXECUTION

3.1 INSTALLATION

Install medium-voltage cables in accordance with NFPA 70.

Install cable in underground duct banks.

3.1.1 Moisture-Testing Before Pulling

Moisture-test cable that has paper insulation before before pulling it into underground ducts. Ensure that radii of bends, potheads, fittings, cable risers, and other conditions are suitable for the cable and conform with the recommendations of the cable manufacturer.

3.1.2 Protection During Splicing Operations

Provide blower to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Make waterproof

protective coverings available on the work site to provide protection against moisture while a splice is being made. Use pumps to keep manholes dry during splicing operations. Never make a splice or termination with the interior of a cable exposed to moisture. Moisture-test conductor insulation paper before the splice is made. Use a manhole ring at least 6 -inches above ground around the manhole entrance to keep surface water from entering the manhole. Plug unused ducts and stop water seepage through ducts in use before the splice is started.

3.1.3 Pulling Cables in Ducts, Manholes and Utility Tunnels

Pull medium-voltage cables into ducts and utility tunnels with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. Employ a sufficient number of trained personnel and equipment to ensure the careful and proper installation of the cable.

Set up cable reel at the side of the manhole or tunnel hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Install flexible tube guide through the opening in a manner that prevents the cable from rubbing on the edges of any structural member.

Allow for a pulling force for a cable grip on lead-sheathed cable that does not exceed 1,500 pounds per square inch of sheath cross-sectional area. Use a dynamometer in the pulling line to ensure that the pulling force is not exceeded. Allow for a pulling force for a nonmetallic-sheathed cable that does not exceed the smaller of 1,000 pounds or a value computed from the following equation:

$$TM = 0.008 \times N \times CM$$

Where: TM = maximum allowable pulling tension in pounds

N = number of conductors in the cable

CM = cross-sectional area of each conductor in circular mils

Unreel cable from the top of the reel. Carefully control payout. Make cable to be pulled be attached through a swivel to the main pulling wire by means of a pulling eye suitable cable grip permitted only on cables less than 200-feet long and less than 2 inches in diameter.

Use woven-wire cable grips to grip the cable end when pulling small cables and short straight lengths of heavier cables.

Attach pulling eyes to the cable conductors to prevent damage to the cable structure.

Use pulling eyes and cable grips together for nonmetallic sheathed cables to prevent damage to the cable structure.

Provide a minimum bending radius in accordance with the following:

CABLE TYPE	MINIMUM BENDING RADIUS MULTIPLIER TIMES CABLE DIAMETER
RUBBER- AND PLASTIC-INSULATED CABLE WITH OR	

CABLE TYPE	MINIMUM BENDING RADIUS MULTIPLIER TIMES CABLE DIAMETER
WITHOUT INTERLOCKED ARMOR	
Shielded cables with shielding tape	12

Liberally coat cables with a suitable cable-pulling lubricant as it enters the tube guide or duct. Use grease and oil lubricants only on lead-sheathed cables. Cover nonmetallic sheathed cables with wire-pulling compounds when required which have no deleterious effects on the cable. Provide rollers, sheaves, or tube guides around which the cable is pulled that conform to the minimum bending radius of the cable.

Pull cables into ducts at a speed not to exceed 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle is not permitted. Stop pulling operations immediately with any indication of binding or obstruction and do not resume until such difficulty is corrected. Provide sufficient slack for free movement of cable due to expansion or contraction.

Make cable splices made up in manholes or utility tunnels that are firmly supported on cable racks as indicated. Do not pull cable splices in ducts. Overlap cable ends at the ends of a section to provide sufficient undamaged cable for splicing. Make cables to be spliced in manholes or utility tunnels overlap the centerline of the proposed joint by not less than 2 feet.

Provide cables cut in the field that have the cut ends immediately sealed to prevent entrance of moisture. Seal nonleaded cables with rubber tape wrapped down to 3 inches from the cable end. Cover-wrap rubber tape with polyvinylchloride tape. Seal lead-covered cables with wiping metal making a firm bond with the end of the sheath or with a disk of lead fitted over the end and wiped to the sheath.

3.1.4 Splices and Terminations

Make splices in manholes or tunnels except where cable terminations are specifically indicated. Expedite splicing and terminating of cables to minimize exposure and cable deterioration.

Terminate cables in potheads. Dry terminations with medium voltage pennants, preformed, and hand wrapped stress cones are allowed for terminating cables. Provide potheads with adequate means for making external connections to the cable conductors of single- conductor cables; protecting the cable insulation against moisture, oil, or other contaminant; physically protecting and supporting cables, and maintaining the insulation level of the cable.

Field-fabricate Pothead terminations from termination kits supplied by and in accordance with the pothead manufacturer's recommendations for the type, size, and electrical characteristics of the cable.

Installation includes built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables and at the terminals of single-conductor lead-covered cables rated 15 kV and above, ungrounded.

Field fabricate cable splices from splicing kits supplied by and in accordance with the cable manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified. Locate cable splices in manholes midway between cable racks on walls of manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

Support all universal demountable splices in such manner so as to minimize physical stress on the splice connections. Support each cable end termination using a pair of saddle type supports under the cable end termination and/or cable with a minimum 12 inches and a maximum 30 inches separation between the supports. Secure cable end termination and cable to the supports in such a manner as to prevent movement of termination or cable at the support. Install saddle type supports on galvanized steel framing channel anchored to the wall or securely fastened to the cable tray or installed by other approved methods.

3.1.5 Single-Conductor Potheads

Provide single-conductor potheads that are the hermetically sealed capnut type and that are suitable for the type, size, and electrical characteristics of the cable specified. Provide potheads that consist of cast bodies, bushings, cable connectors, lugs, and entrance fittings.

Provide pothead bodies that are metal castings with mounting brackets, when required, pipe plugs for filling and vent holes, and machined flanged surface for cable-entrance fitting. Provide bodies that are cast iron for cables up to 250 amperes, and cast aluminum for cable of larger size and higher current ratings.

Provide bushings that are glazed wet-process electrical porcelain insulators, factory assembled and hermetically sealed to the pothead body.

Provide cable connectors that are high-conductivity copper accurately machined and threaded for internal and external electrical connections. Provide adequate cross-sectional and contact areas to carry the full-load current rating of the conductors. Provide solder type cable connectors with gasket seal between the connector and bushing.

Completely fill potheads, leaving no gaps or voids, with an insulating compound suitable for the type of cable, insulation, voltage rating, and ambient operating temperatures in accordance with the pothead manufacturer's recommendations. Ground pothead parts that do not carry current.

3.2 FIELD TESTING

Provide test equipment, labor, and technical personnel as necessary to perform the electrical acceptance tests.

Make arrangements to have tests witnessed and approved by the Contracting Officer.

Completely isolate each power-cable installation from extraneous electrical connections at cable terminations and joints. Observe safety precautions.

First give each power cable a full dielectric-absorption test with 5000-volt insulation-resistance test set. Apply test for a long enough time to fully charge the cable. Record readings every 15 seconds during the

first 3 minutes of test and at 1 minute intervals thereafter. Continue test until three equal readings, 1 minute apart, are obtained. Minimum reading is 200 megohms at an ambient temperature of 68 degrees F. Correct readings taken at other than 68 degrees F ambient temperatures.

Upon successful completion of the dielectric absorption tests, subject the cable to a direct-current high-potential test for 5 minutes with test voltages applied in accordance with AEIC CS1 and IEEE Std 400.2 for paper-impregnated, lead-covered cable; AEIC C8 and IEEE Std 400.2 for cross-linked, polyethylene-insulated cable; and AEIC C8 and IEEE Std 400.2 for ethylene propylene rubber-insulated cable.

Record leakage current readings every 30 seconds during the first 2 minutes and every minute thereafter for the remainder of the test. When the leakage current continues to increase after the first minute, immediately terminate the test and take steps to find and correct the fault. When a second test becomes necessary, repeat this test procedure.

Upon satisfactory completion of the high-potential test, give the cable a second dielectric-absorption test as before.

Provide results of the second dielectric-absorption test that agree with the first test and that indicate no evidence of permanent injury to the cable caused by the high-potential test.

Record test data and include identification of cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.

Final acceptance depends upon the satisfactory performance of the cable under test. Do not energize cable until recorded test data has been approved by the Contracting Officer Provide final test reports to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Report - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Perform Radiographic tests on all potheads at the discretion of the Contracting Officer to determine if voids exist in the pothead. Rework unacceptable terminations at no additional expense to the Government.

-- End of Section --

SECTION 26 05 48.00 10

SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT
10/07

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2005) Manual of Steel Construction

ASTM INTERNATIONAL (ASTM)

ASTM E 580	(2006) Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Moderate Seismic Restraint

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-04	(2007) Seismic Design for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2004; Rev thru May 2006) Luminaires

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Lighting Fixtures in Buildings; G
Panelboards; G

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

1.3 SYSTEM DESCRIPTION

1.3.1 General Requirements

The requirements for seismic protection measures described in this section shall be applied to the electrical equipment and systems listed below.

Structural requirements shall be in accordance with Section 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.3.2 Electrical Equipment

Electrical equipment shall include the following items to the extent required on the drawings or in other sections of these specifications:

Light Fixtures Panelboards
Solar Panels Transformers
Switchboards (Floor Mounted)

1.3.3 Contractor Designed Bracing

The Contractor shall design the bracing in accordance with UFC 3-310-04 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. UFC 3-310-04 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas shall be required. Loadings determined using UFC 3-310-04 are based on strength design; therefore, AISC 325 shall be used for the design. The bracing for the following electrical equipment and systems shall be developed by the Contractor: Conduit systems greater than or equal to 2 1/2 inches trade size. Light fixtures. Panelboards.

1.3.4 Conduits Requiring No Special Seismic Restraints

Seismic restraints may be omitted from electrical conduit less than 2-1/2 inches trade size. All other interior conduit, shall be seismically protected as specified.

1.4 EQUIPMENT REQUIREMENTS

1.4.1 Rigidly Mounted Equipment

The following specific items of equipment to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in UFC 3-310-04. Each item of rigid electrical equipment shall be entirely located and rigidly attached on one side only of a building expansion joint. Piping, electrical conduit, etc., which cross the expansion joint shall be provided with flexible joints that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.

Transformers
Switch Boards

PART 2 PRODUCTS

2.1 LIGHTING FIXTURE SUPPORTS

Lighting fixtures and supports shall conform to UL 1598.

2.2 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL

EQUIPMENT.

PART 3 EXECUTION

3.1 SWAY BRACES FOR CONDUIT

Conduit shall be braced as for an equivalent weight pipe in accordance with Section 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

3.2 LIGHTING FIXTURES IN BUILDINGS

Lighting fixtures and supports shall conform to the following:

3.2.1 Pendant Fixtures

Pendant fixtures shall conform to the requirements of UFC 3-310-04.

3.2.2 Ceiling Attached Fixtures

3.2.2.1 Recessed Fixtures

Recessed individual or continuous-row mounted fixtures shall be supported by a seismic-resistant suspended ceiling support system built in accordance with ASTM E 580 Section 09 51 00 ACOUSTICAL CEILINGS. Seismic protection for the fixtures shall conform to the requirements of UFC 3-310-04. Fixture accessories, including louvers, diffusers, and lenses shall have lock or screw attachments. Support from structure with wire at four-points on fixture (12 gage minimum).

3.2.3 Assembly Mounted on Outlet Box

A supporting assembly, that is intended to be mounted on an outlet box, shall be designed to accommodate mounting features on 4 inch boxes, plaster rings, and fixture studs.

3.2.4 Wall-Mounted Emergency Light Unit

Attachments for wall-mounted emergency light units shall be designed and secured for the worst expected seismic disturbance at the site.

3.2.5 Lateral Force

Structural requirements for light fixture bracing shall be in accordance with Section 26 05 48.00 10 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

-- End of Section --

SECTION 26 08 00

APPARATUS INSPECTION AND TESTING
08/08

PART 1 GENERAL

1.1 REFERENCES

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

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance tests and inspections; G

SD-07 Certificates

Qualifications of organization, and lead engineering technician; G

Acceptance test and inspections procedure; G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification shall be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization shall have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization shall have a calibration program, and test

instruments used shall be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.4.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.4.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer shall be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

a. Section 26 12 19.10 THREE-PHASE PAD-MOUNTED TRANSFORMERS

b. Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION

c. Section 26 13 00.00 20 PAD-MOUNTED SF6 INSULATED INTERRUPTER SWITCHES

d. Section 26 23 00 SWITCHBOARDS AND SWITCHGEAR

3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

-- End of Section --

SECTION 26 12 19.10

THREE-PHASE PAD-MOUNTED TRANSFORMERS
11/09

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM D 1535	(2008) Specifying Color by the Munsell System

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE C57.12.00	(2006) Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.28	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.34	(2004; Errata 2005) Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 2500 kVA and Smaller—High-Voltage: 34 500 GrdY/19 920 Volts and Below; Low Voltage: 480 Volts and Below
IEEE C57.12.90	(2006; INT 2009) Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.98	(1993; R 1999) Guide for Transformer Impulse Tests
IEEE C62.11	(2005; Amendment A 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms
IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

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

10 CFR 431	Energy Efficiency Program for Certain Commercial and Industrial Equipment

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Standard for Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-mounted transformer drawings; G

SD-06 Test Reports

Acceptance checks and tests; G

Submittal shall include acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5; G

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein.

SD-11 Closeout Submittals

Transformer test schedule; G

Submit report of test results as specified by paragraph entitled "Field Quality Control."

1.5 QUALITY ASSURANCE

1.5.1 Pad-Mounted Transformer Drawings

Drawings shall indicate, but not be limited to the following:

a. An outline drawing, with front, top, and side views.

b. ANSI nameplate data.

c. Elementary diagrams and wiring diagrams with terminals identified of watthour meter and current transformers.

d. One-line diagram, including switch(es), current transformers, meters, and fuses.

e. Manufacturer's published time-current curves (on full size logarithmic paper) of the transformer high side fuses.

1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Additions to Operation and Maintenance Data

In addition to requirements of Data Package 5, include the following on the actual transformer(s) provided:

a. An instruction manual with pertinent items and information highlighted

b. An outline drawing, front, top, and side views

c. Prices for spare parts and supply list

d. Routine and field acceptance test reports

e. Fuse curves for primary fuses

f. Actual nameplate diagram

g. Date of purchase

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and related accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

IEEE C57.12.34, IEEE C57.12.28 and as specified herein.

2.2.1 Compartments

The high- and low-voltage compartments shall be separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

2.2.1.1 High Voltage, Dead-Front

High-voltage compartment shall contain the incoming line, insulated high-voltage load-break connectors, bushing well inserts, six high-voltage bushing wells configured for loop feed application, access to oil-immersed fuses, dead-front surge arresters, tap changer handle, connector parking stands, and ground pad.

a. Insulated high-voltage load-break connectors: IEEE Std 386, rated 15 kV, 95 kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

c. Bushing well inserts: IEEE Std 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.

d. Load-break switch.

e. Provide bayonet type, oil-immersed, expulsion fuses. Bayonet fuse links shall sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing which closes when the fuse holder is removed and an external drip shield. Warning shall be conspicuously displayed within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the open position and the tank pressure has been released.

   Bayonet fuse assembly: 150 kV BIL.

f. Surge arresters: IEEE C62.11, rated 15 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap, suitable for plugging into inserts. Provide three arresters for radial feed circuits.

g. Parking stands: Provide a parking stand near each bushing well. Provide insulated standoff bushings for parking of energized load-break connectors on parking stands.

h. Protective caps: IEEE Std 386, 200 amperes, 15 kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushing well inserts and insulated standoff bushings.

2.2.1.2 Low Voltage

Low-voltage compartment shall contain low-voltage bushings with NEMA spade terminals, accessories, metering, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

a. Accessories shall include drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

2.2.2 Transformer

a. Less-flammable or oil-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.

b. Transformer shall be rated 500 kVA, 95 kV BIL.

c. Transformer voltage ratings: 500 V Delta - 480/277 V

d. Tap changer shall be externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Tap changers shall clearly indicate which tap setting is in use.

e. Minimum tested impedance shall not be less than 5.32 percent at 85 degrees C.

f. Audible sound levels shall comply with the following:

kVA	DECIBELS (MAX)
75	51
112.5	55
150	55
225	55
300	55
500	56
750	57
1000	58
1500	60
2000	61
2500	62

g. Transformer shall include lifting lugs and provisions for jacking under base. The transformer base construction shall be suitable for using rollers or skidding in any direction. Provide transformer top with an access handhole. Transformer shall have its kVA rating conspicuously displayed on its enclosure. The transformer shall have an insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.

2.2.2.1 Specified Transformer Efficiencies

Provide transformer efficiency calculations utilizing the no-load and load losses. No-load losses (NLL) shall be referenced at 20 degrees C. Load losses (LL) shall be referenced at 85 degrees C and at 50 percent of the nameplate load. If the tested transformer efficiency is less than the efficiency indicated in 10 CFR 431, Subpart K, paragraph 431.196(b), the transformer is not acceptable.

2.2.3 Insulating Liquid

a. 572 degree F flash type liquid, tested in accordance with ASTM D 117. Provide identification of transformer as "non-PCB" and "type II mineral oil" on the nameplate.

2.2.3.1 Liquid-Filled Transformer Nameplates

Distribution transformers shall be provided with nameplate information in

accordance with IEEE C57.12.00 and as modified or supplemented by this section.

2.2.4 Corrosion Protection

Bases and cabinets of transformers shall be corrosion resistant and shall be fabricated of stainless steel conforming to ASTM A 167, Type 304 or 304L. Base shall include any part of pad-mounted transformer that is within 3 inches of concrete pad.

Paint entire transformer assembly Munsell 7GY3.29/1.5 green. Paint coating system shall comply with IEEE C57.12.28 regardless of base, cabinet, and tank material. The Munsell color notation is specified in ASTM D 1535.

2.3 WARNING SIGNS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

2.4 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

2.5 PADLOCKS

Padlocks will be provided by Government.

2.6 CAST-IN-PLACE CONCRETE

Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day compressive strength unless specified otherwise. All concrete shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

Shall be composed of fine aggregate, coarse aggregate, portland cement, and water so proportioned and mixed as to produce a plastic, workable mixture. Fine aggregate shall be of hard, dense, durable, clean, and uncoated sand. The coarse aggregate shall be reasonably well graded from 3/16 inch to 1 inch. The fine and coarse aggregates shall be free from injurious amounts of dirt, vegetable matter, soft fragments or other deleterious substances. Water shall be fresh, clean, and free from salts, alkali, organic matter, and other impurities. Concrete associated with electrical work for other than encasement of underground ducts shall be 4000 psi minimum 28-day

compressive strength unless specified otherwise. Slump shall not exceed 4 inches. Retempering of concrete will not be permitted. Exposed, unformed concrete surfaces shall be given a smooth, wood float finish. Concrete shall be cured for a period of not less than 7 days, and concrete made with high early strength portland cement shall be repaired by patching honeycombed or otherwise defective areas with cement mortar as directed by the Contracting Officer. Air entrain concrete exposed to weather using an air-entraining admixture conforming to ASTM C 260. Air content shall be between 4 and 6 percent.

2.7 SOURCE QUALITY CONTROL

2.7.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instrument calibration frequency schedule shall not exceed 12 months for both test floor instruments and leased specialty equipment.

4. Dated calibration labels shall be visible on all test equipment.

5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

6. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

   (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

   (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.7.2 Design Tests

IEEE C57.12.00 states that "design tests are made only on representative apparatus to substantiate the ratings assigned to all other apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for the specified transformer(s). Design tests shall have been performed in accordance with IEEE C57.12.90prior to the award of this contract.

a. Tests shall be certified and signed by a registered professional engineer.

b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (ONAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.

c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests shall include the primary windings only of that transformer.

    1. IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.

    2. State test voltage levels.

    3. Provide photographs of oscilloscope display waveforms or plots of digitized waveforms with test report.

d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.

e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.

f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

2.7.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests shall be performed in accordance with IEEE C57.12.90 by the manufacturer on the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence shall be as follows:

a. Phase relation

b. Ratio

c. No-load losses (NLL) and excitation current

d. Load losses (LL) and impedance voltage

e. Dielectric

    1. Impulse

2. Applied voltage

3. Induced voltage

f. Leak

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Pad-Mounted Transformer Grounding

Provide separate copper grounding conductors and connect them to the ground loop as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.5 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible

side, but space the signs a maximum of 30 feet apart.

3.6 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount transformer on concrete slab. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately 4 inches above finished grade with gradual slope for drainage. Edges above grade shall have 1/2 inch chamfer. Slab shall be of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

3.6.1 Cast-In-Place Concrete

Cast-in-place concrete work shall conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.6.2 Sealing

When the installation is complete, the Contractor shall seal all entries into the equipment enclosure with an approved sealing method. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.7 FIELD QUALITY CONTROL

3.7.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.7.1.1 Pad-Mounted Transformers

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.

3. Inspect anchorage, alignment, and grounding.

4. Verify the presence of PCB content labeling.

5. Verify the bushings and transformer interiors are clean.

6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

7. Verify correct liquid level in tanks and bushings.

8. Verify that positive pressure is maintained on gas-blanketed transformers.

9. Perform specific inspections and mechanical tests as recommended by manufacturer.

10. Verify de-energized tap changer position is left as specified.

11. Verify the presence of transformer surge arresters.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

2. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

3. Verify that the top-changer is set at specified ratio.

3.7.1.2 Grounding System

a. Visual and mechanical inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

1. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.7.1.3 Surge Arresters, Medium- and High-Voltage

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Inspect anchorage, alignment, grounding, and clearances.

4. Verify the arresters are clean.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform an insulation-resistance test on each arrester, phase terminal-to-ground.

3. Test grounding connection.

3.7.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times of checking and testing.

-- End of Section --

SECTION 26 13 00.00 20

SF6 INSULATED PAD-MOUNTED SWITCHGEAR
04/06

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM D 1535	(2008) Specifying Color by the Munsell System
ASTM D 2472	(2000; R 2006) Standard Specification for Sulphur Hexafluoride

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE C57.12.28	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C37.72	(1987) Manually-Operated, Dead-Front Padmounted Switchgear with Load Interrupting Switches and Separable Connectors for Alternating-Current Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

NFPA 70B (2006; Errata 2007) Electrical Equipment Maintenance

UNDERWRITERS LABORATORIES (UL)

UL 467 (2007) Standard for Grounding and Bonding Equipment

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS and Section 26 08 00 APPARATUS INSPECTION AND TESTING, apply to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

1.3.1 Switched Way

A switched way is considered a three-phase circuit entrance to the bus through a switch. For single-phase switches, it is a single-phase entrance to the bus through a switch.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchgear Drawings; G

SD-03 Product Data

SF6 Insulated Pad-mounted Switchgear; G
Insulated High-Voltage Connectors; G

Each submittal shall include data on switches and associated accessories. Each submittal shall include manufacturer's information for each component, device and accessory provided with the equipment.

SD-06 Test Reports

Acceptance Checks and Tests; G

SD-09 Manufacturer's Field Reports

Switchgear design and production tests; G

SD-10 Operation and Maintenance Data

SF6 Insulated Pad-mounted Switchgear Operation and Maintenance, Data Package 5; G

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 QUALITY ASSURANCE

1.5.1 Switchgear Drawings

Furnish drawings that include, but are not limited to, the following:

a. Overall dimensions, weights, plan view, and front view

b. Ratings

c. Single-line diagram.

1.5.2 Paint Coating System

Submit paint coating system performance requirement tests.

1.6 MAINTENANCE

1.6.1 SF6 Insulated Pad-mounted Switchgear Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 SF6 INSULATED PAD-MOUNTED SWITCHGEAR

NEMA C37.72

2.1.1 Ratings and Test Requirements

The voltage rating of the switchgear shall be 15.5 kV. The corresponding ratings associated with the required switchgear voltage rating shall be as follows:

Rated Maximum Voltage, kV	15.5
Rated Withstand Impulse Voltage, kV BIL	95
Continuous and Load Interrupting Current, A	600
Short-Time Current, kA rms Sym	12

2.1.2 Switchgear Construction

Switch contacts and cable entrance terminations shall be contained in an SF6 filled stainless steel tank. Switchgear shall be shipped factory filled with SF6 gas conforming to ASTM D 2472. Switchgear shall be configured with load interrupting switched ways as indicated. Switchgear shall have front accessible terminations suitable for cables entering from below. Provide gas pressure gage in viewable location from switch operating handle. Each switched way shall have three position switch; Open, Closed, Ground.

2.1.2.1 Pad-mounting Provisions

Provide enclosed switchgear suitable for installation on a concrete pad. Switchgear enclosure base shall be fabricated of ASTM A 167 type 304 or 304L stainless steel. Enclosure base shall include any part of the switchgear enclosure that is within 3 inches of concrete pad. Paint enclosure including base ASTM D 1535 Munsell 7GY3.29/1.5 green. Paint coating system shall comply with IEEE C57.12.28 regardless of equipment material.

2.1.3 Load Interrupting Switched Ways

Load interrupter switched ways shall provide three-pole group operated switching.

2.1.4 Dead-Front High-Voltage Bushings

IEEE Std 386. 15 kV, 95 kV BIL. Provide 600 ampere one-piece deadbreak apparatus bushings for each switched way.

a. Parking stands: Provide a parking stand near each dead-front bushing. Provide insulated standoff bushings for parking of energized load-break connectors on each parking stands.

2.2 Insulated High-Voltage Connectors

IEEE Std 386. Provide corresponding connector for each switched way. Connectors shall have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

a. 600 Ampere deadbreak connector ratings: Voltage: 15 kV, 95 kV BIL. Short time rating: 40,000 rms symmetrical amperes.

2.3 SF6 Refill Cylinders

Provide two SF6 refill cylinders, minimum size of 6 pounds of SF6; include regulator, valves, and hose for connection to the fill valve of the switch.

2.4 SOURCE QUALITY CONTROL

2.4.1 Switchgear Design and Production Tests

Furnish reports which include results of design and production tests performed according to NEMA C37.72. Production tests shall be performed by the manufacturer on each switchgear assembly to ensure that design performance is maintained in production.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms. When work, in addition to that indicated or specified, is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION at each corner of switchgear pad.

3.2.2 Switchgear Grounding

Connect #4/0 bare copper conductor ground loop, not less than 24 inches below grade, to the upper end of the ground rods by exothermic welds or compression connectors. Provide #4/0 bare copper conductors connecting the switchgear grounding provisions to two different ground rods.

3.2.3 Connections

Make joints in grounding conductors and ground loop by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION.

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount switch on concrete slab. Slab shall be at least 12 inches thick, reinforced with a 6 x 6 - W2.9 x W2.9 mesh, placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. Top of concrete slab shall be approximately 4 inches above finished grade. Edges above grade shall have 1/2 inch chamfer. Slab shall be of adequate size to project at least 8 inches beyond equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with switch cable training areas. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4 FIELD QUALITY CONTROL

3.4.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, NFPA 70B, NETA ATS and referenced ANSI standards.

Include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.4.1.1 Switchgear

a. Visual and Mechanical Inspection

(1) Compare equipment nameplate information with specifications and approved shop drawings.

(2) Inspect physical and mechanical condition.

(3) Check for proper anchorage, alignment, required area clearances, and grounding.

(4) Perform mechanical operator tests in accordance with manufacturer's instructions.

(5) Verify that insulating SF6 gas pressure is correct.

(6) Inspect all indicating devices for proper operation.

b. Electrical Tests

(1) Perform contact-resistance tests.

(3) Perform insulation-resistance tests.

(4) Perform an over-potential test on each switched way pole with the switched way in the open position in accordance with the manufacturer's instructions.

3.4.1.2 Grounding System

a. Visual and Mechanical Inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.4.2 Follow-Up Verification

Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that devices are in good operating condition and properly performing the intended function. Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times for checks and tests.

-- End of Section --

SECTION 26 18 23.00 40

MEDIUM-VOLTAGE SURGE ARRESTERS
08/08

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.11	(2005; Amendment A 2008) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE Std 386	(2006) Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LA 1	(1992; R 1999) Standard for Surge Arresters

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Equipment and Performance Data for surge arresters including life, test, system functional flows, safety features, and mechanical automated details.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Submit Equipment and Performance Data for surge arresters in

accordance with paragraph entitled, "General Requirements," of this section.

Submit Manufacturer's product data for the following items:

Surge Arresters; G
Mounting Brackets; G

SD-08 Manufacturer's Instructions

Installation Instructions; G
Surge Arresters; G

SD-10 Operation and Maintenance Data

O & M Manuals; G
Surge Arresters; G

PART 2 PRODUCTS

2.1 EQUIPMENT

Provide design, fabrication, testing, and performance of arresters that complies with IEEE C62.11, NEMA LA 1.

Provide arresters that utilize metal oxide varistor and gapped arrester technologies.

Provide arresters that are contained within a polymer housing. Provide arrester that is designed to be non-fragmenting to provide extra safety to personnel and equipment. For arresters utilizing a hanger frame type mounting bracket, provide a frame that is non-corrosive track resistant glass filled polyester or other suitable non-corrosive/non-conductive material providing high mechanical strength. Provide arrester mounting hardware that is designed for installation in severe salt-spray atmosphere and that is of a corrosion-resistant metal or zinc-coated in accordance with ASTM A 123/A 123M.

The arrester housing is molded of EPDM insulating rubber which provides deadfront safety and overvoltage system protection in an insulated, fully shielded, submersible, deadfront device that conforms to IEEE Std 386.

2.2 SURGE ARRESTERS

2.2.1 O & M Manuals, Surge Arresters

Provide O & M Manuals for surge arresters specified within these plans and specifications.

2.2.2 Station

Provide single-phase, single-pole, self-supporting type arresters for pedestal, platform, or bracket mounting.

2.3 MOUNTING BRACKETS

Provide arresters that are equipped with suitable mounting brackets for the applicable method of mounting.

PART 3 EXECUTION

3.1 INSTALLATION

Install and connect arresters in accordance with the manufacturer's installation instructions.

Make ground connection to a driven ground rod, counterpoise, or station grounding system and meet the intent of the National Electrical Code, NFPA 70.

3.1.1 Installation Instructions, Surge Arresters

Submit Manufacturer's instructions for surge arresters including special provisions required to install equipment components and system packages. Provide special notices that detail impedances, hazards and safety precautions.

3.1.2 Installation Drawings

Submit installation drawings in accordance with paragraph entitled, "Installation," of this section.

-- End of Section --

SECTION 26 20 00

INTERIOR DISTRIBUTION SYSTEM
08/08

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM B 1	(2001; R 2007) Standard Specification for Hard-Drawn Copper Wire
ASTM B 8	(2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C80.1	(2005) Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA C80.3	(2005) Standard for Electrical Metallic Tubing (EMT)
NEMA C80.5	(2005) Standard for Electrical Rigid Aluminum Conduit (ERAC)
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems General

	Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 4	(2005) Industrial Control and Systems: Terminal Blocks
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures
NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA RN 1	(2005) Standard for Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992; R 1997) Standard for Dry-Type Transformers for General Applications
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
NEMA TC 3	(2004) Standard for Polyvinyl Chloride PVC Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TP 1	(2002) Guide for Determining Energy Efficiency for Distribution Transformers
NEMA WD 1	(1999; R 2005) Standard for General Requirements for Wiring Devices
NEMA WD 6	(2002; R 2008) Standard for Wiring Devices - Dimensional Requirements
NEMA Z535.4	(2007; Errata 2007) Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition
NFPA 70E	(2009; Errata 2009) Standard for Electrical Safety in the Workplace

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA J-STD-607-A	(2002) Commercial Building Grounding (Earthing) and Bonding Requirements for

	Telecommunications
TIA-568-C.1	(2009) Commercial Building Telecommunications Cabling Standard
TIA/EIA-569-A	(1998; Addenda 2000, 2001) Commercial Building Standards for Telecommunications Pathways and Spaces

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

29 CFR 1910.147	Control of Hazardous Energy (Lock Out/Tag Out)

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Rev thru Jul 2007) Standard for Flexible Metal Conduit
UL 1063	(2006) Standard for Safety Machine-Tools Wires and Cables
UL 1242	(2006; Rev thru Jul 2007) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 1449	(2006; Rev thru Sep 2009) Surge Protective Devices
UL 1660	(2004; Rev thru Jan 2005) Liquid-Tight Flexible Nonmetallic Conduit
UL 198M	(2003; Rev thru Oct 2007) Mine-Duty Fuses
UL 20	(2000 ; Rev thru Dec 2008) Standard for General-Use Snap Switches
UL 360	(2009; Rev thru Jun 2009) Liquid-Tight Flexible Steel Conduit
UL 44	(2005; Rev thru Nov 2005) Thermoset-Insulated Wires and Cables
UL 467	(2007) Standard for Grounding and Bonding Equipment
UL 486A-486B	(2003; Rev thru Apr 2009) Standard for Wire Connectors
UL 486C	(2004; Rev thru Apr 2009) Standard for Splicing Wire Connectors
UL 489	(2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 498	(2001; Rev thru Jul 2009) Attachment Plugs and Receptacles

UL 50	(2007) Standard for Enclosures for Electrical Equipment
UL 508	(1999; Rev thru Sep 2008) Standard for Industrial Control Equipment
UL 510	(2005; Rev thru Aug 2005) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 512	(1993; Rev thru Jan 2008) Fuseholders
UL 514A	(2004; Rev thru Oct 2009) Standard for Metallic Outlet Boxes
UL 514B	(2004; Rev thru Nov 2009) Standard for Conduit, Tubing and Cable Fittings
UL 6	(2007) Standard for Electrical Rigid Metal Conduit-Steel
UL 651	(2005; Rev thru May 2007) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL 67	(2009) Standard for Panelboards
UL 6A	(2008) Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 797	(2007) Standard for Electrical Metallic Tubing -- Steel
UL 83	(20086) Standard for Thermoplastic-Insulated Wires and Cables
UL 854	(2004; Rev thru Oct 2007) Service-Entrance Cables
UL 870	(1995; Rev thru Jul 2003) Standard for Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2006; Rev thru Feb 2008) Ground-Fault Circuit-Interrupters

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards; G
Transformers; G

SD-03 Product Data

Receptacles; G
Circuit breakers; G
Switches; G
Transformers; G
Enclosed circuit breakers; G
Motor controllers; G
Metering; G

SD-06 Test Reports

600-volt wiring test; G
Grounding system test; G
Ground-fault receptacle test; G

1.4 QUALITY ASSURANCE

1.4.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 MAINTENANCE

1.5.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. This shall include:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.7 SEISMIC REQUIREMENTS

Seismic details shall conform to Section 26 05 48.00 10, SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials, equipment, and devices shall, as a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70.

2.2 CONDUIT AND FITTINGS

Shall conform to the following:

2.2.1 Rigid Metallic Conduit

2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

NEMA C80.1, UL 6.

2.2.1.2 Rigid Aluminum Conduit

NEMA C80.5, UL 6A.

2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-40, and EPC-80 in accordance with NEMA TC 2,UL 651.

2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, NEMA C80.3.

2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40(40 mils thick).

2.2.6 Flexible Metal Conduit

UL 1.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

Steel screw type.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.2.9 Liquid-Tight Flexible Nonmetallic Conduit

UL 1660.

2.3 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal.

2.3.1 Floor Outlet Boxes

Boxes shall be adjustable and concrete tight. Each outlet shall consist of or cast-metal body with threaded openings, for conduits, adjustable, brass flange ring, and cover plate with 3/4 and 1 1/4 inch threaded plugs. Telecommunications outlets shall consist of flush, aluminum or stainless steel housing with a receptacle as specified and 1 1/4 inch bushed side opening. Receptacle outlets shall consist of 1 flush aluminum or stainless steel housing with duplex-type receptacle as specified herein. Provide gaskets where necessary to ensure watertight installation.

2.3.2 Outlet Boxes for Telecommunications System

Provide standard type 4 inches square by 2 1/8 inches deep. Outlet boxes for wall-mounted telecommunications outlets shall be 4 by 2 1/8 by 2 1/8 inches deep. Depth of boxes shall be large enough to allow manufacturers' recommended conductor bend radii.

2.4 WIRES AND CABLES

Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

2.4.1 Conductors

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and capacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.4.1.1 Minimum Conductor Sizes

Minimum size for branch circuits shall be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; for Class 2 low-energy, remote-control and signal circuits, No. 16 AWG; and for Class 3 low-energy, remote-control, alarm and signal circuits, No. 22 AWG.

2.4.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals shall be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems shall be as follows:

a. 208/120 volt, three-phase

   (1) Phase A - black

   (2) Phase B - red

   (3) Phase C - blue

b. 480/277 volt, three-phase

   (1) Phase A - brown

   (2) Phase B - orange

   (3) Phase C - yellow

2.4.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN/THHN conforming to UL 83, except that grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.4.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.4.5 Service Entrance Cables

Service Entrance (SE) and Underground Service Entrance (USE) Cables, UL 854.

2.5 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.6 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. For metal outlet boxes, plates on unfinished walls shall be of zinc-coated sheet steel or cast metal having round or beveled edges. For nonmetallic boxes and fittings, other suitable plates may be provided. Plates on finished walls shall be satin finish stainless steel or brushed-finish aluminum, minimum 0.03 inch thick. Screws shall be machine-type with countersunk heads in color to match finish of plate. Sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations."

2.7 SWITCHES

2.7.1 Toggle Switches

NEMA WD 1, UL 20, single pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Handles shall be white thermoplastic. Wiring terminals shall be screw-type, side-wired. Contacts shall be silver-cadmium and contact arm shall be one-piece copper alloy. Switches shall be rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

2.7.2 Switch with Red Pilot Handle

NEMA WD 1. Provide pilot lights that are integrally constructed as a part of the switch's handle. The pilot light shall be red and shall illuminate whenever the switch is closed or "on". The pilot lighted switch shall be rated 20 amps and 120 volts or 277 volts as indicated. Provide the circuit's neutral conductor to each switch with a pilot light.

2.7.3 Breakers Used as Switches

For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.7.4 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Fused switches shall utilize Class R fuseholders and fuses, unless indicated

otherwise. Switches serving as motor-disconnect means shall be horsepower rated. Provide switches in NEMA 1 or 3R, enclosure as indicated per NEMA ICS 6.

2.8 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Time-current characteristics curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Submit coordination data for approval. Fuses shall have voltage rating not less than circuit voltage.

2.8.1 Fuseholders

Provide in accordance with UL 512.

2.8.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198M, Class RK-5 time-delay type. Associated fuseholders shall be Class R only.

2.8.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 198M, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

2.8.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 198M, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

2.9 RECEPTACLES

UL 498, hard use, heavy-duty, grounding-type. Ratings and configurations shall be as indicated. Bodies shall be of white as per NEMA WD 1. Face and body shall be thermoplastic supported on a metal mounting strap. Dimensional requirements shall be per NEMA WD 6. Provide screw-type, side-wired wiring terminals. Connect grounding pole to mounting strap. The receptacle shall contain triple-wipe power contacts and double or triple-wipe ground contacts.

2.9.1 Switched Duplex Receptacles

Provide separate terminals for each ungrounded pole. Top receptacle shall be switched when installed.

2.9.2 Weatherproof Receptacles

Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations with plug in use."

2.9.3 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices. Provide screw-type,

side-wired wiring terminals or pre-wired (pigtail) leads.

2.10 PANELBOARDS

UL 67 and UL 50 having a short-circuit current rating as indicated. Panelboards shall be circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise. Main breaker shall be "separately" mounted "above" branch breakers. Where "space only" is indicated, make provisions for future installation of breakers. Directories shall indicate load served by each circuit in panelboard. Directories shall also indicate source of service to panelboard (e.g., Panel PA served from Panel MDP). Type directories and mount in holder behind transparent protective covering. Panelboards shall be listed and labeled for their intended use. Panelboard shall have nameplates in accordance with paragraph FIELD FABRICATED NAMEPLATES.

2.10.1 Enclosure

Enclosures shall meet the requirements of UL 50. All cabinets shall be fabricated from sheet steel of not less than No. 10 gauge if flush-mounted or mounted outdoors, and not less than No. 12 gauge if surface-mounted indoors, with full seam-welded box ends. Cabinets mounted outdoors or flush-mounted shall be hot-dipped galvanized after fabrication. Cabinets shall be painted in accordance with paragraph PAINTING. Outdoor cabinets shall be of NEMA 3R raintight. Front edges of cabinets shall be form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front. All cabinets shall be so fabricated that no part of any surface on the finished cabinet shall deviate from a true plane by more than 1/8 inch. Holes shall be provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface. Flush doors shall be mounted on hinges that expose only the hinge roll to view when the door is closed. Each door shall be fitted with a combined catch and lock, except that doors over 24 inches long shall be provided with a three-point latch having a knob with a T-handle, and a cylinder lock. Two keys shall be provided with each lock, and all locks shall be keyed alike. Finished-head cap screws shall be provided for mounting the panelboard fronts on the cabinets.

2.10.2 Panelboard Buses

Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet. In addition to equipment grounding bus, provide second "isolated" ground bus, where indicated.

2.10.3 Circuit Breakers

UL 489, thermal magnetic-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the

circuit breaker shall be mounted. Breaker terminals shall be UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.10.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.10.3.2 Circuit Breakers for HVAC Equipment

Circuit breakers for HVAC equipment having motors (group or individual) shall be marked for use with HACR type and UL listed as HACR type.

2.11 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated.

2.12 TRANSFORMERS

NEMA ST 20, general purpose, dry-type, self-cooled, ventilated. Provide transformers in NEMA 1 enclosure. Transformer shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation for transformers rated 10 kVA and less, with temperature rise not exceeding 115 degrees C under full-rated load in maximum ambient of 40 degrees C. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

2.12.1 Specified Transformer Efficiency

Transformers, indicated and specified with: 480V primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, shall be energy efficient type. Minimum efficiency, based on factory test results, shall not be less than NEMA Class 1 efficiency as defined by NEMA TP 1.

2.13 MOTOR CONTROLLERS

UL 508, NEMA ICS 1, and NEMA ICS 2. Controllers shall have thermal overload protection in each phase and shall have one spare normally open and one spare normally closed auxiliary contact. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay. Magnetic-type motor controllers shall have undervoltage protection when used with momentary-contact pushbutton stations or switches and shall have undervoltage release when used with maintained-contact pushbutton stations or switches. When used with pressure, float, or similar automatic-type or maintained-contact switch, controller shall have hand/off/automatic selector switch. Connections to selector switch shall be such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload

protective devices, shall be connected in motor control circuit in "hand" and "automatic" positions. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device shall be made in accordance with indicated or manufacturer's approved wiring diagram. Selector switch shall have means for locking in any position. For each motor not in sight of controller or where controller disconnecting means is not in sight of motor location and driven machinery location, controller disconnecting means shall be capable of being locked in open position. As an alternative, provide a manually operated, lockable, nonfused switch which disconnects motor from supply source within sight of motor. Overload protective devices shall provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case. Cover of combination motor controller and manual switch or circuit breaker shall be interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.

2.13.1 Control Wiring

All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of control wire shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 12 AWG. Special attention shall be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.13.2 Control Circuit Terminal Blocks

NEMA ICS 4. Control circuit terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts. The terminals shall be removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer and not less than four (4) spare terminals or 10 percent, whichever is greater, shall be provided on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. The Contractor shall submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.13.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks shall meet the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and

of adequate capacity shall be provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to operate without overheating. Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.13.3 Control Circuits

Control circuits shall have maximum voltage of 120 volts derived from a separate control source. Provide terminals and terminal boards. Provide separate control disconnect switch within controller. One secondary lead shall be fused; other shall be grounded.

2.13.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.13.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers shall have compelling relays and shall be multiple-button, station-type with pilot lights for each speed.

2.13.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations shall be heavy duty, oil-tight design.

2.13.7 Pilot and Indicating Lights

Provide LED cluster lamps.

2.14 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with requirements of Division 23, "Mechanical."

2.15 GROUNDING AND BONDING EQUIPMENT

2.15.1 Ground Rods

UL 467. Ground rods shall be copper-clad steel, with minimum diameter of 3/4 inch and minimum length of 10 feet.

2.15.2 Ground Bus

A copper ground bus shall be provided in the electrical equipment rooms as indicated.

2.16 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.17 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.18 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. The marking shall be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.19 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations in accordance with Section 07 84 00, FIRESTOPPING.

2.20 WIREWAYS

UL 870. Material shall be steel galvanized 16 gauge for heights and depths up to 6 by 6 inches, and 14 gauge for heights and depths up to 12 by 12 inches. Provide in length required for the application with hinged- cover NEMA 1 enclosure per NEMA ICS 6.

2.21 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices which comply with UL 1449 at the service entrance. Provide surge protectors in a NEMA 1 enclosure per NEMA ICS 6. Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Each phase to neutral (L-N)
Neutral to ground (N-G)
Phase to ground (L-G)

Surge protective devices at the service entrance shall have a minimum surge current rating of 20,000 amperes per mode minimum. The maximum line to neutral (L-N) Suppressed Voltage Rating (SVR) shall be:

900V for 480Y/277V, three phase system

The minimum MCOV (Maximum Continuous Operating Voltage) rating shall be:

600/320V for 480Y/277V, three phase system

2.22 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Exterior surfaces shall be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Exterior surfaces shall be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish. Equipment located indoors shall be ANSI Light Gray, and equipment located outdoors shall be ANSI Light Gray. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.23 SOURCE QUALITY CONTROL

2.23.1 Transformer Factory Tests

Submittal shall include routine NEMA ST 20 transformer test results on each transformer and also contain the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces, shall conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

3.1.1 Underground Service

Underground service conductors and associated conduit shall be continuous from service entrance equipment to outdoor power system connection.

3.1.2 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures shall be labeled and identified as such.

3.1.2.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, shall be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, shall indicate number of service disconnect devices housed by enclosure and shall indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one

enclosure, shall be provided only as permitted by NFPA 70.

3.1.3 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size shall be 3/4 inch in diameter for low voltage lighting and power circuits. Conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors shall be firestopped in accordance with Section 07 84 00, FIRESTOPPING.

3.1.3.1 Pull Wire

Install pull wires in empty conduits. Pull wire shall be plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.

3.1.4 Conduit Installation

Unless indicated otherwise, conceal conduit under floor slabs and within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project.

3.1.4.1 Restrictions Applicable to Aluminum Conduit

a. Do not install underground or encase in concrete or masonry.

b. Do not use brass or bronze fittings.

c. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.2 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors.

f. Do not use in fire pump rooms.

g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.3 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 40 and PVC Schedule 80

(1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, hospitals, power plants, missile magazines, and other such areas.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in fire pump rooms.

(4) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(5) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

(6) Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

(8) Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.4.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS.

3.1.4.5 Service Entrance Conduit, Underground

PVC, Type-EPC 40. Underground portion shall be encased in minimum of 3 inches of concrete and shall be installed minimum 18 inches below slab or grade.

3.1.4.6 Underground Conduit Other Than Service Entrance

Plastic-coated rigid steel; plastic-coated steel IMC; PVC, Type EPC-40. Convert PVC Schedule 40 or 80, to plastic-coated rigid, steel conduit before rising through floor slab. Plastic coating shall extend minimum 6 inches above floor.

3.1.4.7 Conduit Installed Under Floor Slabs

Conduit run under floor slab shall be located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.4.8 Conduit Through Floor Slabs

Where conduits rise through floor slabs, curved portion of bends shall not be visible above finished slab.

3.1.4.9 Conduit Installed in Concrete Floor Slabs

Rigid steel; steel IMC; or PVC, Type EPC-40. Locate so as not to adversely affect structural strength of slabs. Install conduit within middle one-third of concrete slab. Do not stack conduits. Space conduits horizontally not closer than three diameters, except at cabinet locations.

Curved portions of bends shall not be visible above finish slab. Increase slab thickness as necessary to provide minimum one inch cover over conduit. Where embedded conduits cross building and/or expansion joints, provide suitable watertight expansion/deflection fittings and bonding jumpers. Expansion/deflection fittings shall allow horizontal and vertical movement of raceway. Conduit larger than one inch trade size shall be parallel with or at right angles to main reinforcement; when at right angles to reinforcement, conduit shall be close to one of supports of slab. Where nonmetallic conduit is used, raceway shall be converted to plastic coated rigid steel or plastic coated steel IMC before rising above floor, unless specifically indicated.

3.1.4.10 Stub-Ups

Provide conduits stubbed up through concrete floor for connection to free-standing equipment with adjustable top or coupling threaded inside for plugs, set flush with finished floor. Extend conductors to equipment in rigid steel conduit, except that seal-tight flexible metal conduit may be used 6 inches above floor. Where no equipment connections are made, install screwdriver-operated threaded flush plugs in conduit end.

3.1.4.11 Conduit Support

Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceiling shall be vibration resistant and shock-resistant. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system. Conduit and box systems shall be supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Installation shall be coordinated with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners may be used for lighting branch circuit conduit supports in suspended ceilings in dry locations. Where conduit crosses building expansion joints, provide suitable watertight expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.4.12 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.4.13 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.4.14 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be 1/2 inch diameter. Provide liquidtight flexible conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.4.15 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with TIA/EIA-569-A.

a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room shall be installed and cabling length requirements in accordance with TIA-568-C.1. Size conduits in accordance with TIA/EIA-569-A and as indicated.

b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling) shall be installed in accordance with TIA/EIA-569-A. Size conduits for telecommunications risers in accordance with TIA/EIA-569-A and as indicated.

3.1.5 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 7 feet above floors and walkways, and when specifically indicated. Boxes in other locations shall be sheet steel, except that aluminum boxes may be used with aluminum conduit. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces,

cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.5.1 Boxes

Boxes for use with raceway systems shall be minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets shall be a minimum of 4 inches square by 2 1/8 inches deep, except for wall mounted telephones and outlet boxes for handicap telephone stations. Mount outlet boxes flush in finished walls.

3.1.5.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.5.3 Extension Rings

Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.

3.1.6 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches and handicapped telecommunications stations 48 inches above finished floor. Mount receptacles and telecommunications outlets 18 inches above finished floor, unless otherwise indicated. Measure mounting heights of wiring devices and outlets in non-hazardous areas to center of device or outlet.

3.1.7 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.

3.1.7.1 Marking Strips

White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for wire designations. The wire numbers shall be made with permanent ink. The marking strips shall be reversible to permit marking both sides, or two marking strips shall be furnished with each block. Marking strips shall accommodate the two sets of

wire numbers. Each device to which a connection is made shall be assigned a device designation in accordance with NEMA ICS 1 and each device terminal to which a connection is made shall be marked with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits shall be provided for the Government's wire designations. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.8 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.9 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.10 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings in accordance with Section 07 84 00, FIRESTOPPING.

3.1.11 Grounding and Bonding

Provide In accordance with NFPA 70. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA J-STD-607-A. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.11.1 Ground Rods

Provide cone pointed ground rods. The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 5 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods not less than 6 feet on centers. In

high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer who will decide on the number of ground rods to add.

3.1.11.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. 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.

3.1.11.3 Ground Bus

A copper ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment.

3.1.11.4 Resistance

Maximum resistance-to-ground of grounding system shall not exceed 5 ohms under dry conditions.

3.1.12 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications but shall be provided under the section specifying the associated equipment.

3.1.13 Government-Furnished Equipment

Contractor shall make connections to Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.1.14 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00, PAINTS AND COATINGS.Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer 5 working days notice prior to each test.

3.5.1 Devices Subject to Manual Operation

Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 250,000 ohms.

3.5.3 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.

3.5.4 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

-- End of Section --

SECTION 26 23 00

SWITCHBOARDS
07/06

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 653/A 653M	(2009a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780/A 780M	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D 1535	(2008) Specifying Color by the Munsell System
ASTM D 709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE C37.20.1	(2002; Addenda A 2005; Addenda B 2006; R 2007) Standard for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear
IEEE C57.12.28	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)Normal Measurements

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA C12.1	(2008) Electric Meters; Code for Electricity Metering
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures
NEMA LI 1	(1998) Industrial Laminated Thermosetting Products
NEMA PB 2	(2006) Deadfront Distribution Switchboards
NEMA PB 2.1	(2007) General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 1558	(1999; Rev thru Jun 2009) Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
UL 467	(2007) Standard for Grounding and Bonding Equipment
UL 489	(2009) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 891	(2005) Dead-Front Switchboards

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as

defined in IEEE Std 100.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchboard Drawings; G

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

SD-03 Product Data

Switchboard

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G
Equipment Test Schedule; G
Request for Settings; G

1.5 QUALITY ASSURANCE

1.5.1 Switchboard Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchboard including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings

b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

1.5.2 Switchboard Drawings

Drawings shall include, but are not limited to the following:

a. One-line diagram including breakers, current transformers, and meters

b. Outline drawings including front elevation, section views, footprint, and overall dimensions

c. Bus configuration including dimensions and ampere ratings of bus bars

d. Markings and NEMA nameplate data

e. Circuit breaker type, interrupting rating, and trip devices, including available settings

f. Three-line diagrams and elementary diagrams and wiring diagrams with terminals identified, and indicating prewired interconnections between items of equipment and the interconnection between the items.

g. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device. These shall be used by the designer of record to provide breaker settings that will ensure protection and coordination are achieved.

1.5.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.2 Assembled Operation and Maintenance Manuals

Manuals shall be assembled and bound securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data".

b. Catalog data required by the paragraph entitled, "SD-03, Product Data".

c. Drawings required by the paragraph entitled, "SD-02, Shop Drawings".

d. Prices for spare parts and supply list.

e. Information on metering

f. Design test reports

g. Production test reports

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be switchboards and related accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION SYSTEM, and Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2 SWITCHBOARD

NEMA PB 2 and UL 891IEEE C37.20.1 and UL 1558.

2.2.1 Ratings

The voltage rating of the switchboard shall be volts, as indicated. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall be as indicated. The switchboard shall be UL listed and labeled for its intended use for distribution or as service entrance equipment.

2.2.2 Construction

Switchboard shall consist of vertical sections bolted together to form a

rigid assembly and shall be rear aligned. All circuit breakers shall be front accessible. Rear aligned switchboards shall have front accessible load connections. Compartmentalized switchboards shall have vertical insulating barriers between the front device section, the main bus section, and the cable compartment with full front to rear vertical insulating barriers between adjacent sections. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections, instrumentation, and control wiring.

2.2.2.1 Enclosure

The switchboard enclosure shall be an indoor NEMA ICS 6 Type 1. Enclosure shall be bolted together with removable bolt-on side and rear covers. Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of galvanized steel. Base shall include any part of enclosure that is within 3 inches of concrete pad. Galvanized steel shall be ASTM A 123/A 123M, ASTM A 653/A 653M G90 coating, and ASTM A 153/A 153M, as applicable. Galvanize after fabrication where practicable. Paint enclosure, including bases, ASTM D 1535 light gray No. 61 or No. 49. Paint coating system shall comply with IEEE C57.12.28 for galvanized steel.

2.2.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide minimum one-quarter by 2 inch copper ground bus secured to each vertical section along the entire length of the switchboard. The neutral bus shall be rated 100 percent of the main bus continuous current rating as indicated.

2.2.2.3 Main Section

The main section shall consist of molded-case circuit breaker and utility transformer compartment.

2.2.2.4 Distribution Sections

The distribution sections shall consist of individually mounted, molded-case circuit breakers as indicated.

2.2.2.5 Auxiliary Sections/Compartments

Auxiliary sections shall consist of indicated metering equipment, and current transformer compartments as indicated.

2.2.2.6 Handles

Handles for individually mounted devices shall be of the same design and method of external operation. Label handles prominently to indicate device ampere rating, color coded for device type. Identify ON-OFF indication by handle position and by prominent marking.

2.2.3 Protective Device

2.2.3.1 Molded-Case Circuit Breaker

UL 489. UL listed and labeled, 100 percent rated, stationary,, manually operated, low voltage molded-case circuit breaker, with a short-circuit current rating of as indicated at 480 volts. Breaker frame size shall be as indicated. Series rated circuit breakers are unacceptable.

2.2.4 Electronic Trip Units

Equip main breakers as indicated with a solid-state tripping system consisting of three current sensors and a microprocessor-based trip unit that will provide true rms sensing adjustable time-current circuit protection. The ampere rating of the current sensors shall be the same as the breaker frame rating. The trip unit ampere rating shall be as indicated. The electronic trip units shall have the following features.

a. MainBreakers shall have long delay pick-up and time settings, and LED indication of cause of circuit breaker trip.

b. Main breakers shall have short delay pick-up and time settings.

d. Main Breakers shall have a digital display for phase and ground current.

e. Main Breakers shall have a digital display for watts, vars, VA, kWh, kvarh, and kVAh.

f. Main Breakers shall have a digital display for phase voltage, and percent THD voltage and current.

g. Main Breakers shall have provisions for communication via a network twisted pair cable for remote monitoring and control.

2.2.5 Watthour and Digital Meters

2.2.5.1 Digital Meters

Main breaker shall have Square D Power Logiv Series 4000 Circuit Monitor Model CM4250, with Model CMDVF display and Model ECC21 ethernet communications card. No substitutions will be allowed.

2.2.6 Current Transformers

IEEE C57.13. Transformers shall be single ratio, 60 hertz, 800 to 5-ampere ratio, 2.0 rating factor, with a metering accuracy class of 0.3 through B-0.5.

2.2.7 Meter Fusing

Provide a fuse block mounted in the metering compartment containing one fuse per phase to protect the voltage input to voltage sensing meters. Size fuses as recommended by the meter manufacturer.

2.2.8 Terminal Boards

Provide with engraved plastic terminal strips and screw type terminals for external wiring between components and for internal wiring between removable assemblies. Terminal boards associated with current transformers

shall be short-circuiting type. Terminate conductors for current transformers with ring-tongue lugs. Terminal board identification shall be identical in similar units. External wiring shall be color coded consistently for similar terminal boards.

2.2.9 Wire Marking

Mark control and metering conductors at each end. Provide factory-installed, white, plastic tubing, heat stamped with black block type letters on factory-installed wiring. On field-installed wiring, provide white, preprinted, polyvinyl chloride (PVC) sleeves, heat stamped with black block type letters. Each sleeve shall contain a single letter or number, shall be elliptically shaped to securely grip the wire, and shall be keyed in such a manner to ensure alignment with adjacent sleeves. Provide specific wire markings using the appropriate combination of individual sleeves. Each wire marker shall indicate the device or equipment, including specific terminal number to which the remote end of the wire is attached.

2.3 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.4 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each switchboard, equipment enclosure, relay, switch, and device; as specified in this section or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.5 SOURCE QUALITY CONTROL

2.5.1 Equipment Test Schedule

The Government reserves the right to witness tests. Provide equipment test schedules for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled date.

a. Test Instrument Calibration

1. The manufacturer shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.

3. Instrument calibration frequency schedule shall not exceed 12

months for both test floor instruments and leased specialty equipment.

4. Dated calibration labels shall be visible on all test equipment.

5. Calibrating standard shall be of higher accuracy than that of the instrument tested.

6. Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:

   (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

   (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.5.2 Switchboard Design Tests

NEMA PB 2 and UL 891.

2.5.2.1 Design Tests

Furnish documentation showing the results of design tests on a product of the same series and rating as that provided by this specification.

a. Short-circuit current test

b. Enclosure tests

c. Dielectric test

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of the ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Equipment Grounding

Provide bare copper cable not smaller than No. 4/0 AWG not less than 24 inches below grade connecting to the indicated ground rods. When work in addition to that indicated or specified is directed to obtain the specified ground resistance, the provision of the contract covering "Changes" shall

apply.

3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION, paragraph entitled "Grounding Connections."

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Switchboard

NEMA PB 2.1.

3.3.2 Meters and Instrument Transformers

NEMA C12.1.

3.3.3 Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

3.3.4 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A 780/A 780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.3.5 Field Fabricated Nameplate Mounting

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.4.1 Interior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches thick. The top of the concrete slab shall be approximately 4 inches above finished floor. Edges above floor shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

Contractor shall submit request for settings of breakers to the Contracting Officer after approval of switchboard and at least 30 days in advance of their requirement.

3.5.1 Performance of Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.5.1.1 Switchboard Assemblies

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical, electrical, and mechanical condition.

3. Confirm correct application of manufacturer's recommended lubricants.

4. Verify appropriate anchorage, required area clearances, and correct alignment.

5. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

6. Verify that circuit breaker sizes and types correspond to approved shop drawings.

7. Verify that current transformer ratios correspond to approved shop drawings.

8. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

9. Confirm correct operation and sequencing of electrical and mechanical interlock systems.

10. Clean switchboard.

11. Inspect insulators for evidence of physical damage or contaminated surfaces.

12. Verify correct barrier installation.

13. Exercise all active components.

14. Inspect all mechanical indicating devices for correct operation.

15. Verify that vents are clear.

16. Test operation, alignment, and penetration of instrument transformer withdrawal disconnects.

17. Inspect control power transformers.

b. Electrical Tests

1. Perform insulation-resistance test on control wiring; Do not perform this test on wiring connected to solid-state components.

3.5.1.2 Circuit Breakers

Low Voltage Molded Case with Solid State Trips

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect circuit breaker for correct mounting.

3. Operate circuit breaker to ensure smooth operation.

4. Inspect case for cracks or other defects.

5. Inspect all bolted electrical connections for high resistance using low resistance ohmmeter, verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method, or performing thermographic survey.

6. Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

1. Perform contact-resistance tests.

2. Perform insulation-resistance tests.

3. Perform Breaker adjustments for final settings in accordance with Government provided settings.

3.5.1.3 Current Transformers

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify correct connection.

4. Verify that adequate clearances exist between primary and secondary circuit.

5. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.

6. Verify that all required grounding and shorting connections

provide good contact.

3.5.1.4 Metering and Instrumentation

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify tightness of electrical connections.

b. Electrical Tests

1. Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

2. Calibrate watthour meters according to manufacturer's published data.

3. Verify all instrument multipliers.

4. Electrically confirm that current transformer and voltage transformer secondary circuits are intact.

3.5.1.5 Grounding System

a. Visual and Mechanical Inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. IEEE Std 81. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

2. Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device.

Test shall require each item to perform its function not less than three times. As an exception to requirements stated elsewhere in the contract, the Contracting Officer shall be given 5 working days advance notice of the dates and times for checks, settings, and tests.

-- End of Section --

SECTION 26 24 16.00 40

PANELBOARDS
11/08

PART 1 GENERAL

1.1 REFERENCES

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA PB 1	(2006; Errata 2008) Standard for Panelboards

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 67	(2009) Standard for Panelboards

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Detail Drawings for the panelboards consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents. Include within drawings details of bus layout.

Ensure Outline Drawings for panelboards indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00

SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Detail Drawings; G and Outline Drawings; G for panelboards in accordance with paragraph entitled, "General Requirements," of this section.

SD-08 Manufacturer's Instructions

Submit Manufacturer's instructions for Panelboards;G including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 PANELBOARDS

Totally enclose power-distribution panelboards and lighting and appliance branch-circuit panelboards in a steel cabinet, dead-front circuit breaker type with copper buses, surface- or flush-mounted as indicated. Ensure panelboards conform to NEMA PB 1 and NEMA AB 1. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on surface-mounted panelboards to provide gutter space access. Provide a center door for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Provide four-wire distribution panelboards and lighting and appliance branch-circuit panelboards with an isolated full-capacity neutral bus. Ensure panelboards are rated for 240-volt (maximum), single-phase 120/208-volt, three-phaseand 277/480-volt, three-phase, 60-hertz current.

Provide three-phase, 4-wire and single-phase, 3-wire distribution lighting and branch circuit panelboards with an isolated full-capacity bus providing spaces for single-pole circuit breakers/switches and spaces indicated as spare.

Provide panelboards with a separate grounding bus bonded to the enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated.

Ensure panelboards and main lugs or main breaker have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Three-phase, four-wire busing shall be such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto.

Panelboard box shall be galvanized code-gage sheet steel without knockouts. Ensure entire panelboard front is hinged on one side with a piano hinge for the full height and has captive screws opposite the hinged side. Where panelboards are installed flush with the walls, the installation details shall be such that the hinged front can be opened without damage to the adjacent wall surfaces. Ensure that the color of the finished coat of trim and front matches the adjacent walls except when the box is installed in electrical closets or equipment rooms, the gray finish as specified is acceptable.

Panelboard enclosures shall be NEMA 250, Type 1. Provide enclosures with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks. Key locks alike and provide two keys for each enclosure.

Finish panelboards with baked enamel. Finish color is to be No. 61 gray conforming to FED-STD-595.

2.2 CIRCUIT BREAKERS

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers in 120/208 -volt panelboards shall be not less than 10,000 amperes rms symmetrical, and that for breakers in 277/480 -volt panelboards shall be not less than 10,000 amperes rms symmetrical.

Circuit breakers shall be bolt-on type. Plug-in type is not acceptable.

Provide shunt trips where indicated.

In branch circuit panelboards, branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Single-pole 15- and 20-ampere circuit breakers shall be UL listed as "Switching Breakers" at 120 volts ac and 277 volts ac. This protection is an integral part of the branch circuit breaker that also provides overload and short-circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption is not to disturb the feeder circuit to the panelboard. A single-pole circuit breaker with integral ground fault circuit interruption requires no more panelboard branch circuit space than a conventional slide pole circuit breaker.

Ensure connections to the bus are bolt-on type.

When multiple wires per phase are specified, furnish the circuit breakers with connectors made to accommodate multiple wires.

Ensure circuit breaker spaces called out on the drawings are complete with mounting hardware to permit ready installation of the circuit breakers.

2.3 DIRECTORY CARD AND HOLDER

Mount a directory card on the inside of hinged fronts and doors 0.030-inch thick minimum plastic in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Directory card shall identify each

branch circuit with its respective and numbered circuit breaker.

2.4 FACTORY TESTING

Test complete panelboards in accordance with UL 67.

2.5 PRECAUTIONARY LABEL

To ensure persons are aware of immediate or potential hazard in the application, installation, use, or maintenance of panelboards, each panelboard shall be conspicuously marked on the trim or dead front shield with the text (or equivalent) **DANGER** symbol. If the panel is supplied with a door, ensure the label is visible when the door is in the open position.

PART 3 EXECUTION

3.1 INSTALLATION

Install panelboards as indicated and in accordance with the manufacturer's instructions. Fully align and mount panels so that the height of the top operating handle does not exceed 72-inches above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

3.2 SITE TESTING

Each panelboard enclosure key shall be shown to operate the enclosure locks in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Provide test equipment, labor, and personnel as required to perform the tests as specified. Conduct continuity tests using a dc device with bell or buzzer.

Conduct insulation tests on 480-volt panelboards using a 1,000-volt insulation-resistance test set. Record readings every minute until three equal and consecutive readings have been obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Conduct insulation tests on panelboards rated 300 volts or less using a 500-volt minimum insulation-resistance test set. Record readings after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Record test data and include the location and identification of panelboards and megohm readings versus time.

-- End of Section --

SECTION 26 29 23

VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS
04/06

PART 1 GENERAL

1.1 REFERENCES

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(1992; R 1993; Errata 2004) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 3.1	(2009) Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers
NEMA ICS 6	(1993; R 2001; R 2006) Enclosures
NEMA ICS 7	(2006) Adjustable-Speed Drives

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; TIA 08-1) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-461	(2007; Rev F) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

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

47 CFR 15	Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 489	(2009) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 508C	(2002; R thru 2010) Power Conversion Equipment

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, and Section 26 20 00 DISTRIBUTION WIRING SYSTEM apply to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements

1.3.1.1 Electromagnetic Interference Suppression

Computing devices, as defined by 47 CFR 15, MIL-STD-461 rules and regulations, shall be certified to comply with the requirements for class A computing devices and labeled as set forth in part 15.

1.3.1.2 Electromechanical and Electrical Components

Electrical and electromechanical components of the Variable Frequency Drive (VFD) shall not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

1.3.2 Electrical Requirements

1.3.2.1 Power Line Surge Protection

IEEE C62.41.1 and IEEE C62.41.2, IEEE 519 Control panel shall have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge arrestor shall be mounted near the incoming power source and properly wired to all three phases and ground. Fuses shall not be used for surge protection.

1.3.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.4 SUBMITTALS

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

approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Schematic diagrams; G
Interconnecting diagrams; G
Installation drawings; G

Submit drawings for government approval prior to equipment construction or integration. Modifications to original drawings made during installation shall be immediately recorded for inclusion into the as-built drawings.

SD-03 Product Data

Variable frequency drives; G
Wires and cables
Equipment schedule

Include data indicating compatibility with motors being driven.

SD-06 Test Reports

VFD Test
Performance Verification Tests
Endurance Test

SD-08 Manufacturer's Instructions

Installation instructions

SD-09 Manufacturer's Field Reports

VFD Factory Test Plan; G

Factory test results

SD-10 Operation and Maintenance Data

Variable frequency drives, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Submit additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program. Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

1.5 QUALITY ASSURANCE

1.5.1 Schematic Diagrams

Show circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional assemblies as devices, provided that sufficient information is provided for government maintenance personnel to verify proper operation of the functional assemblies.

1.5.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

1.5.3 Installation Drawings

Show floor plan of each site, with V.F.D.'s and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes.

1.5.4 Equipment Schedule

Provide schedule of equipment supplied. Schedule shall provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule shall include the total quantity of each item of equipment supplied. For complete assemblies, such as VFD's, provide the serial numbers of each assembly, and a sub-schedule of components within the assembly. Provide recommended spare parts listing for each assembly or component.

1.5.5 Installation instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

1.5.6 Factory Test Results

Document test results and submit to government within 7 working days after completion of test.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 WARRANTY

The complete system shall be warranted by the manufacturer for a period of one year, or the contracted period of any extended warrantee agreed upon by the contractor and the Government, after successful completion of the acceptance test. Any component failing to perform its function as specified and documented shall be repaired or replaced by the contractor at no additional cost to the Government. Items repaired or replaced shall be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in the FAR CLAUSE 52.246-21.

1.8 MAINTENANCE

1.8.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

1.8.2 Maintenance Support

During the warranty period, the Contractor shall provide on-site, on-call maintenance services by Contractor's personnel on the following basis: The service shall be on a per-call basis with 36 hour response. Contractor shall support the maintenance of all hardware and software of the system. Various personnel of different expertise shall be sent on-site depending on the nature of the maintenance service required. Costs shall include travel, local transportation, living expenses, and labor rates of the service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (VFD)

Provide frequency drive to control the speed of induction motor(s). The VFD shall include the following minimum functions, features and ratings.

a. Input circuit breaker per UL 489 with a minimum of 10,000 amps symmetrical interrupting capacity and door interlocked external operator.

b. A converter stage per UL 508C shall change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter shall utilize a full wave bridge design incorporating diode rectifiers. Silicon Controlled Rectifiers (SCR) are not acceptable. The converter shall be insensitive to three phase rotation of the ac line and shall not cause displacement power factor of less than .95 lagging under any speed and load condition.

c. An inverter stage shall change fixed dc voltage to variable frequency, variable voltage, ac for application to a standard NEMA design B squirrel cage motor. The inverter shall be switched in a manner to produce a sine coded pulse width modulated (PWM) output waveform.

d. The VFD shall be capable of supplying 120 percent of rated full load current for one minute at maximum ambient temperature.

e. The VFD shall be designed to operate from a 460 or 208 volt, + or - 10 percent, three phase, 60 Hz supply, and control motors with a corresponding voltage rating.

f. Acceleration and deceleration time shall be independently adjustable from one second to 60 seconds.

g. Adjustable full-time current limiting shall limit the current to a

preset value which shall not exceed 120 percent of the controller rated current. The current limiting action shall maintain the V/Hz ratio constant so that variable torque can be maintained. Short time starting override shall allow starting current to reach 175 percent of controller rated current to maximum starting torque.

h. The controllers shall be capable of producing an output frequency over the range of 3 Hz to 60 Hz (20 to one speed range), without low speed cogging. Over frequency protection shall be included such that a failure in the controller electronic circuitry shall not cause frequency to exceed 110 percent of the maximum controller output frequency selected.

i. Minimum and maximum output frequency shall be adjustable over the following ranges: 1) Minimum frequency 3 Hz to 50 percent of maximum selected frequency; 2) Maximum frequency 40 Hz to 60 Hz.

j. The controller efficiency at any speed shall not be less than 96 percent.

k. The controllers shall be capable of being restarted into a motor coasting in the forward direction without tripping.

l. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controllers to any of the following conditions shall not result in component failure or the need for fuse replacement:

1. Short circuit at controller output

2. Ground fault at controller output

3. Open circuit at controller output

4. Input undervoltage

5. Input overvoltage

6. Loss of input phase

7. AC line switching transients

8. Instantaneous overload

9. Sustained overload exceeding 115 percent of controller rated current

10. Over temperature

11. Phase reversal

m. Solid state motor overload protection shall be included such that current exceeding an adjustable threshold shall activate a 60 second timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down.

n. A slip compensation circuit shall be included which will sense changing motor load conditions and adjust output frequency to

provide speed regulation of NEMA B motors to within + / - 0.5 percent of maximum speed without the necessity of a tachometer generator.

o. The VFD shall be factory set for manual restart after the first protective circuit trip for malfunction (overcurrent,undervoltage, overvoltage or overtemperature) or an interruption of power. The VFD shall be capable of being set for automatic restart after a selected time delay. If the drive faults again within a specified time period (adjustable 0-60 seconds), a manual restart will be required.

p. The VFD shall include external fault reset capability. All the necessary logic to accept an external fault reset contact shall be included.

q. Provide critical speed lockout circuitry to prevent operating at frequencies with critical harmonics that cause resonant vibrations. The VFD shall have a minimum of three user selectable bandwidths.

r. Provide the following operator control and monitoring devices mounted on the front panel of the VFD:

1. Manual speed potentiometer.

2. Hand-Off-Auto (HOA) switch.

3. Power on light.

4. Drive run power light.

5. Local display.

s. Provide properly sized NEMA rated by-pass and isolation contactors to enable operation of motor in the event of VFD failure. Mechanical and electrical interlocks shall be installed between the by-pass and isolation contactors. Provide a selector switch and transfer delay timer.

2.2 ENCLOSURES

Provide equipment enclosures conforming to NEMA 250, NEMA ICS 7, NEMA ICS 6.

2.3 WIRES AND CABLES

All wires and cables shall conform to NEMA 250, NEMA ICS 7, NFPA 70.

2.4 NAMEPLATES

Nameplates external to NEMA enclosures shall conform with the requirements of Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS. Nameplates internal to enclosures shall be manufacturer's standard, with the exception that they must be permanent.

2.5 SOURCE QUALITY CONTROL

2.5.1 VFD Factory Test Plan

To ensure quality, each VFD shall be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test plans and test reports.

PART 3 EXECUTION

3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the drive manufacturer shall supervise the installation of all equipment, and wiring.

3.2 FIELD QUALITY CONTROL

Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Contractor shall conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Contractor shall submit a signed copy of the test results, certifying proper system operation before scheduling tests.

3.2.1 VFD Test

A proposed test plan shall be submitted to the contracting officer at least 28 calendar days prior to proposed testing for approval. The tests shall conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. The Government reserves the right to witness all tests and review any documentation. The contractor shall inform the Government at least 14 working days prior to the dates of testing. Contractor shall provide video tapes, if available, of all training provided to the Government for subsequent use in training new personnel. All training aids, texts, and expendable support material for a self-sufficient presentation shall be provided, the amount of which to be determined by the contracting officer.

3.2.2 Performance Verification Tests

"Performance Verification Test" plan shall provide the step by step procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. The contractor shall inform the Government 14 calendar days prior to the date the test is to be conducted.

3.2.3 Endurance Test

Immediately upon completion of the performance verification test, the endurance test shall commence. The system shall be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness

level of .9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. During the endurance test, the contractor shall not be allowed in the building. The system shall respond as designed.

3.3 DEMONSTRATION

3.3.1 Training

Coordinate training requirements with the Contracting Officer.

3.3.1.1 Instructions to Government Personnel

Provide the services of competent instructors who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach. The Government personnel designated to attend the training will have a high school education or equivalent. The number of training days of instruction furnished shall be as specified. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals shall be turned over to the Government at the end of last training session.

3.3.1.2 Operating Personnel Training Program

Provide one 2 hour training session at the site at a time and place mutually agreeable between the Contractor and the Government. Provide session to train 4 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. Alarm formats

e. Failure recovery procedures

f. Troubleshooting

3.3.1.3 Engineering/Maintenance Personnel Training

Accomplish the training program as specified. Training shall be conducted on site at a location designated by the Government. Provide a one day training session to train 4 engineering personnel in the functional operations of the system. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. System configuration

e. Alarm formats

f. Failure recovery procedures

g. Troubleshooting and repair

h. Maintenance and calibration

i. System programming and configuration

-- End of Section --

SECTION 26 35 33.00 40

PHOTOVOLTAIC SYSTEM
08/10

PART 1 GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplemtary conditions and Division 01 Specification Sections, apply to this section.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit connection Wiring Diagrams; G and shop drawings; G for complete PV system.

SD-03 Product Data

Submit catalog data on all materials and all other related equipment with complete description of components.

Submit manufacturer's catalog data for the following items:

PV Modules; G
Inverters; G
Combiner Boxes; G
Disconnect Switches; G
Panelboard; G
Mounting Hardware; G
Fuses; G
Cable; G
Connectors; G

SD-04 Samples

Submit any component fabricated by contractor for which there is no catalog cut sheet or manufacturer's data avaialable, submit prototype or product for review and approval.

SD-07 Certificates

Submit company information showing experience and other data indication qualifications as outlined under Quality Assurance.

Qualification of Installer; G

1.3 QUALITY ASSURANCE

Installation and equipment shall comply with all applicable codes,

including but not limited to, article 690, 480 and 250 of the 2008 NEC. All products that are listed, tested, identified, or labeled by UL, FM, ETL, or other National Testing Organization shall be used when available. Inverter shall be listed as eligible equipment by the California Energy Commission.

The system components shall be supplied by manufacturers (or certified representative) with an established reputation and at least 5 years experience in the manufacturing of Photovoltaic Energy Systems of 5KW nominal or larger. Installer shall have minimum 5 years experience.

1.4 OPERATION AND MAINTENANCE DATA

Provide two complete sets of the following data. Data shall be on 8 1/2 inch by 11 inch sheet or manufacturer's standard catalog, suitable for side binding. Include full product documentation from manufacturer, installer and/or supplier including, but not limited to, the following items.

INVERTER, INCLUDING OPTIONAL EQUIPMENT FURNISHED

a. Owners manual with programming and installation instructions.
b. Emergency operating procedures.
c. Default program values and setpoints.
d. Listing of field programmed variables and setpoints.
e. Equipment wiring diagrams.
f. Product model number, with name, address, and telephone number of local representative.
g. Starting, operating, and shutdown procedures, including normal, seasonal, and emergency shutdown procedure.
h. Schedule of maintenance work, if any.
i. Replacement parts list, including internal fuses.
j. Warranty paperwork.

PHOTOVOLTAIC MODULES, COMBINER BOXES, SWITCHES, FUSES AND BALANCE OF SYSTEM COMPONENTS:

a. Owners manual or manufacturer's product data sheet, as applicable.
b. Equipment wiring diagrams.
c. product model number, with name, address, and telephone number of local representative.
d. starting, operating, and shutdown procedures, including normal, emergency and seasonal shutdown procedures.
e. Schedule of maintenance work, if any.
f. Replacement parts list, including fuses, diodes, etc.
g. Warranty paperwork.
h. PV module cleaning agents and methods.

PART 2 PRODUCTS

2.1 CONDUIT

Exposed conduit on roof shall be EMT, painted to match roof. Reference in Section 26 05 00.00 40 COMMON WORK RESULT FOR ELECTRICAL for other conduit and raceway requirements.

2.2 CONDUCTORS

As specified in this section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, as shown on drawings and as recommended by the equipment manufacturer.

2.3 PHOTOVOLTAIC MODULES

General: Modules shall be UL, FM, or ETL listed. High-power type, with typical peak power of not less than 235W under standard test conditions (cell temperature of 25°C). Voltage at peak power shall not be less than 30.0 Vdc. Current at peak power shall not be less than 7.5 amps. Short circuit of 8.6 amps maximum, and open circuit voltage at 37.0VDC maximum. Dimension shall not be greater than: length 65 in., width 40 in., height. Model NU-U235F1 as manufactured by SHARP, or approved equal.

Units shall have a minimum 20-year limited warranty that guarantees:

a. That no module will generate less than its specified minimum power when purchased.
b. Continued power of at least 80% of guaranteed minimum power for 20 years.

2.4 COMBINER BOX

Photovoltaic panel circuit combiner box with NEMA type 3R enclosure, integral circuit fuses, terminal blocks, and hinged cover. Model CB-12H20-3R as manufactured by Xantrex, or approved equal. Rated for minimum 190 amp output current. Accommodates a minimum of twelve circuits, individually fused at 20 amps each. Output wire range minimum to # 1/0 AWG. Vertical wall Mounts of secured structure.

2.5 POWER DISTRIBUTION BLOCKS

As required for changing conductors sizes, combining multiple conductors, etc. Rated for voltage and current of system. As manufactured by ILSCO, Cincinnati, Ohio or approved equal.

2.6 DISCONNECTS

General: Circuit breaker and switches shall be UL listed and DC rated for load controlled. Disconnects and overcurrent devices shall be mounted in approved boxes, enclosures, or panelboards. Requirements for internal configuration of these enclosures shall comply with NEC Articles 370, 373, 384 and applicable UL standards. Metal enclosures and boxes shall be bonded to the grounding conductor.

a. DC disconnects (at photovoltaic panel row end): Heavy-duty, 600 VDC, 30-amp, 2-pole, fused (20A) disconnect with isolated neutral bus. NEMA 3R enclosure. Model as manufactured by Square-D or approved equal.
b. DC disconnects (inverter input): Heavy duty, 600VDC, 200A, fused (150A).

2.7 INVERTER

General: Model PVS-50 as manufactured by Satcon Power Systems, or approved equal. DC power center shall have at a minimum the following features:

a. UL-1741 listed.
b. Nominal DC Input Voltage Range: 305-600VDC.
c. Nominal DC Input Current Maximum: 172ADC.
d. Continuous power rating of 50KW; continuous AC output rating of 60A @ 480VAC, 60Hz.

e. Minimum efficiency of 95%.
f. NEMA type 1 enclosure, G90 steel, floor mount.
g. AC output Characteristics: Sinewave output, Voltage Regulation +10%/-12%, maximum. Allowed power factor from 0.8 lag to 0.8 lead. Frequency regulation shall not exceed +/-5%.
h. Non-Operating temperature range -30°C to 70°C, operating temperature range -20°C to 50°C.

PART 3 EXECUTION

3.1 GENERAL

Install all equipment in accordance with manufacturer's recommendations and as required by 2008 NEC. A permanent label shall be posted near the main PV disconnect switch that contains the following information per NEC 690-52:

a. Operating current (system's maximum power current)
b. Open-circuit current
c. Operating voltage (system's maximum power voltage)
d. Open-circuit voltage

3.2 GROUNDING

As indicated on the drawings. Maintain a single point ground conductor throughout the PV system, connecting all equipment enclosures and module frames.

3.3 MODULES

General: Individual modules shall be tested before being installed on roof. Record open-circuit voltage and short-circuit current for each panel. Submit these test results to Engineer. Panels shall be installed to mounting brackets as shown on the drawings. Installation and attachment structure shall be able to withstand wind loading typical for the area.

Wiring: All Wiring shall be neatly routed and secured with wire ties to underside of array. Wire routing shall be such that maximum protection from the elements is provided.

3.4 TESTING

Complete inverter function test.

Test entire system under typical and maximum load conditions.

The total testing period shall not be less than 5 hours

Retest entire system and associated equipment if initial test requires corrective action.

Provide written record of all current and voltage readings on DC and AC sides of inverter.

3.5 DEMONSTRATION AND TRAINING

Provide 4 hours of operating and maintenance instructions for entire PV energy system, including operating of inverter.

-- End of Section --

SECTION 26 51 00

INTERIOR LIGHTING
07/07

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 641/A 641M	(2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

GREEN SEAL (GS)

GC-12	(1997) Occupancy Sensors

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA HB-9	(2000; Errata 2004; Errata 2005) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE C62.41.1	(2002; R 2008) IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C78.81	(2005) Electric Lamps - Double-capped Fluorescent Lamps Dimensional and Electrical Characteristics
NEMA C78.901	(2005) Electric Lamps - Single Base Fluorescent Lamps Dimensional and Electrical Characteristics

NEMA C82.11	(2002) High-Frequency Fluorescent Lamp Ballasts

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2009; Amd 1 & 2 2009) Life Safety Code
NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2008; Rev thru Jan 2010) Luminaires
UL 20	(2000 ; Rev thru Dec 2008) Standard for General-Use Snap Switches
UL 773	(1995; Rev thru Mar 2002) Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2006) Nonindustrial Photoelectric Switches for Lighting Control
UL 924	(2006; Rev thru Oct 2009) Standard for Emergency Lighting and Power Equipment
UL 935	(2001; Rev thru Nov 2009) Standard for Fluorescent-Lamp Ballasts

1.2 RELATED REQUIREMENTS

Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

c. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SYSTEM DESCRIPTION

1.4.1 Lighting Control System

Provide lighting control system as indicated. Lighting control equipment

shall include, if indicated: control modules, power packs, dimming ballasts, occupancy sensors, and light level sensors.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Data, drawings, and reports shall employ the terminology, classifications, and methods prescribed by the IESNA HB-9, as applicable, for the lighting system specified.

SD-03 Product Data

LED lighting fixtures; G
Dimmer switch; G
Lighting Control Panel; G
Photocell switch; G
Exit signs; G
Emergency lighting equipment; G
Occupancy sensors; G
Electronic dimming ballast; G
Dimming ballast controls; G
Light Level Sensor; G

SD-06 Test Reports

Operating test; G

Submit test results as stated in paragraph entitled "Field Quality Control."

SD-10 Operation and Maintenance Data

Lighting Control System; G, Data Package 5

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein, showing all light fixtures, control modules, control zones, occupancy sensors, light level sensors, power packs, dimming ballasts, schematic diagrams and all interconnecting control wire, conduit, and associated hardware.

Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

1.6 QUALITY ASSURANCE

1.6.1 Lighting Fixtures, Complete With Lamps and Ballasts

Submit one sample of each fixture type for inspection, review, and approval. The sample shall be retained for comparison against the remainder of the fixtures. The sample may be used in the final fixture installation.

1.6.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6.3.3 Energy Efficiency

Comply with National Energy Policy Act and Energy Star requirements for lighting products. Submit data indicating lumens per watt efficiency and color rendition index of light source.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 OPERATIONAL SERVICE

Coordinate with manufacturer for maintenance agreement. Collect information from the manufacturer about maintenance agreement options, and submit to Contracting Officer. Services shall reclaim materials for recycling and/or reuse. Services shall not landfill or burn reclaimed materials. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

PART 2 PRODUCTS

2.1 LED LIGHTING FIXTURES

Provide UL listed LED recessed flat panel, downlight and lowboy fixtures with dimmable drivers (as indicated), and integrated heat sinks.

a. Driver shall be suitable for 277V, 60Hz lighting circuits. Dimmable driver shall allow lumer reduction to 5% of full fixture output rating.

b. Light quality shall be 3500k-4500k temperature with minimum 85 color rendering index (CRI) for downlights.

c. Life cycle rated for 50,000 hours with 30% lumen reduction.

d. Light quality shall be 5000k - 6000k color temperature with minimum 70CRI for recessed flat panel 2'x2' and 2'x4' fixtures.

2.1.1 Fluorescent Lamp Electronic Dimming Ballast

The electronic ballast shall as a minimum meet the following characteristics:

a. Ballast shall comply with NEMA C82.11, UL 935, and NFPA 70, unless specified otherwise. Ballast shall provide transient immunity as recommended by IEEE C62.41.1 and IEEE C62.41.2. Ballast dimming capability range shall be from 100 to 5 percent (minimum range) of light output, flicker free. Ballast shall start lamp at any preset light output setting without first having to go to full light output. Ballast shall be designed for the wattage of the lamps used in the indicated application. Ballasts shall be designed to operate on the voltage system to which they are connected.

b. Power factor shall be 0.95 (minimum) at full light output, and 0.90 (minimum) over the entire dimming range.

c. Ballast shall operate at a frequency of 20,000 Hertz (minimum). Ballast shall be compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.

d. Ballast factor at full light output shall be between 0.85 (minimum) and 1.00 (maximum). Current crest factor shall be 1.7 (maximum).

e. Ballast shall be UL listed Class P with a sound rating of "A".

f. Ballast shall have circuit diagrams and lamp connections displayed on the ballast.

g. Ballast shall be programmed start. Ballast may operate lamps in a series circuit configuration. Provide series/parallel wiring for programmed start ballasts where available.

h. Ballasts for compact fluorescent fixtures shall be programmed start.

i. Ballast shall be capable of starting and maintaining operation at a minimum of 0 degrees F unless otherwise indicated.

j. Total harmonic distortion (THD): Shall be 20 percent (maximum) over the entire dimming range.

k. Ballasts for T-5 and smaller lamps shall have end-of-life protection circuits as required by NEMA C78.81 and NEMA C78.901 as applicable.

2.1.2 Light Level Sensor

UL listed. Light level sensor shall be capable of detecting changes in ambient lighting levels, shall provide a dimming range of 20 percent to 100 percent, minimum, and shall be designed for use with dimming ballast and voltage system to which they are connected. Sensor light level shall be adjustable and have a set level range from 10 to 100 footcandles, minimum. Sensor shall have a bypass function to electrically override sensor control.

2.2 RECESS- AND FLUSH-MOUNTED FIXTURES

Provide type that can be relamped from the bottom. Access to LED drivershall be from the top. Trim for the exposed surface of flush-mounted fixtures shall be as indicated.

2.3 SUSPENDED FIXTURES

Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer provided in shops or hangers to limit swinging. Rods shall be a minimum 0.18 inch diameter.

2.4 SWITCHES

2.4.1 Toggle Switches

Provide toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.4.2 Dimmer Switch

UL 20, single-pole, 600 watt, 120 volt ac, full-range rotary on-off type with built-in electromagnetic interference filter.

2.5 PHOTOCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 277 volts ac, 60 Hz with single-throw contacts. Switch shall turn on at or below 3 footcandles and off at 2 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide switch:

a. In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.

2.6 EXIT SIGNS

UL 924, NFPA 70, and NFPA 101. Exit signs shall be self-powered type. Exit signs shall use no more than 5 watts.

2.6.1 Self-Powered LED Type Exit Signs (Battery Backup)

Provide with automatic power failure device, and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit sign shall have emergency run time of 1 1/2 hours (minimum). The light emitting diodes shall have rated lamp life of 70,000 hours (minimum).

2.7 EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 70, and NFPA 101. Provide lamps in wattage indicated.

2.7.1 Emergency Lighting Unit

Provide as indicated. Emergency lighting units shall be rated for 12 volts, except units having no remote-mounted lamps and having no more than two unit-mounted lamps may be rated 6 volts. Provide integral self-testing module.

2.8 OCCUPANCY SENSORS

UL listed. Comply with GC-12. Occupancy sensors and power packs shall be designed to operate on the voltage indicated. Sensors and power packs shall have circuitry that only allows load switching at or near zero current crossing of supply voltage. Occupancy sensor mounting as indicated. Sensor shall have an LED occupant detection indicator. Sensor shall have adjustable sensitivity and adjustable delayed-off time range of 5 minutes to 30minutes. Wall mounted sensors shall be white, ceiling mounted sensors shall be white. Ceiling mounted sensors shall have 360 degree coverage unless otherwise indicated.

a. Ultrasonic/Infrared Combination Sensor

Occupancy detection to turn lights on requires both ultrasonic and infrared sensor detection. Lights shall remain on if either the ultrasonic or infrared sensor detects movement. Infrared sensor shall have lens selected for indicated usage and daylight filter to prevent short wavelength infrared interference. Ultrasonic sensor frequency shall be crystal controlled.

2.9 SUPPORT HANGERS FOR LIGHTING FIXTURES IN SUSPENDED CEILINGS

2.9.1 Wires

ASTM A 641/A 641M, galvanized regular coating, soft temper, inches in diameter (12 gage).

2.9.2 Rods

Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.10 EQUIPMENT IDENTIFICATION

2.10.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be

acceptable.

2.10.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. All luminaires shall be clearly marked for operation of specific LEDs and drivers according to proper type.

2.11 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Lighting Fixtures

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Installation shall meet requirements of NFPA 70. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed fixtures shall be independently supported from the building structure by a minimum of four wires per fixture and located near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by a minimum of four wires per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires for lighting fixture support in this section. Lighting fixtures installed in suspended ceilings shall also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

3.1.2 Suspended Fixtures

Suspended fixtures shall be provided with 45 degree swivel hangers so that they hang plumb and shall be located with no obstructions within the 45 degree range in all directions. The stem, canopy and fixture shall be capable of 45 degree swing. Pendants, rods, or chains 4 feet or longer excluding fixture shall be braced to prevent swaying using three cables at 120 degree separation. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points

shall be 10 feet or as recommended by the manufacturer, whichever is less.

3.1.3 Electronic Dimming Ballasts

All electronic dimming ballasts controlled by the same controller shall be of the same manufacturer. All fluorescent lamps on electronic dimming ballast control shall be seasoned or burned in at full light output for 100 hours before dimming.

3.1.4 Exit Signs and Emergency Lighting Units

Wire exit signs and emergency lighting units ahead of the switch to the normal lighting circuit located in the same room or area.

3.1.5 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.

3.1.6 Occupancy Sensor

Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage shall provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage. Set sensor "on" duration to 30 minutes.

3.1.7 Light Level Sensor

Locate light level sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for 50 footcandles or for the indicated light level at the typical work plane for that area.

3.2 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.3 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

3.3.1 Electronic Dimming Driver

Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

3.3.2 Occupancy Sensor

Test sensors for proper operation. Observe for light control over entire area being covered.

-- End of Section --

SECTION 26 52 00.00 40

EMERGENCY LIGHTING
11/08

PART 1 GENERAL

1.1 REFERENCES

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2009; Amd 1 & 2 2009) Life Safety Code
NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

UNDERWRITERS LABORATORIES (UL)

UL 924	(2006; Rev thru Oct 2009) Standard for Emergency Lighting and Power Equipment

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Material, Equipment, and Fixture Lists showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Submit the manufacturer's catalog data for the following items:

Emergency Lighting Egress Units; G

SD-06 Test Reports

Submit test reports showing results of System Operational Tests; G for emergency lighting systems.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Provide emergency lighting units conforming to UL 924 and NFPA 101.

Furnish emergency lighting units completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Equip fixtures with lamps.

2.2 EMERGENCY LIGHTING EGRESS UNITS

Provide complete self-contained emergency lighting units with batteries, battery charger, one or more local or remote lamp heads with lamps, under-voltage relay, indicator lights, on/off switch, and test switch, in accordance with UL 924 for Type I (emergency light set), Class I (rechargeable storage-battery-powered unit), Style D (nonrefillable nickel-cadmium battery), as indicated.

Provide batteries rated not less than 6-12 volts.

Include in battery charger a dry-type full-wave rectifier with two charging rates, one to automatically maintain the battery in a fully charged state under normal conditions and the other to automatically recharge the battery to a fully charged state within 12 hours after continuous discharge of 1-1/2 hours through the connected lampload.

Provide batteries with the capacity and rating to supply the lamp load with maintained 87.5 -percent power, minimum, for 1.5 hours. Provide maintenance-free nickel-cadmium type batteries, with a minimum normal life of 10 years.

Fabricate the unit enclosure from polycarbonate or sheet steel not less than 18 gage. Design of cover is to provide access to the battery and battery-charger compartments. Protect component parts within the enclosure from dust, moisture, and oxidizing fumes from the battery.

Provide sealed-beam type lamps, halogen, rated not less than 12 watts at the specified dc voltage.

Provide an under-voltage relay of the self-clearing type which automatically connects the lampload to the battery supply upon failure of the alternating current supply.

Provide emergency lighting units suitable for operation on the ac supply circuit to which they are to be electrically connected.

2.3 SELF-TESTING MODULE

Provide self-testing module for exit signs and emergency lighting equipment which performs the following functions:

a. Continuous monitoring of charger operation and battery voltage with visual indication of normal operation and of malfunction.

b. Monthly discharge cycling of battery with monitoring of transfer circuit function, battery capacity and emergency lamp operation with visual indication of malfunction. Conduct the battery capacity test using a synthetic load.

c. Manual test switch to simulate a discharge test cycle.

d. Provide module with low voltage battery disconnect (LVD) and brown-out protection circuit.

PART 3 EXECUTION

3.1 INSTALLATION

Permanently fix in place the emergency lighting unit and install wiring for each unit in accordance with NFPA 70. Use the same panel bus or branch circuit as that serving the normal lighting in the area for the branch circuit feeding the unit equipment, and connect ahead of area switches. Keep remotely connected emergency lighting circuit wiring independent of all other wiring and equipment and do not enter the same conduit, cable, box, or cabinet with other wiring unless the fixture is supplied from two sources.

Mount emergency lighting units at a minimum of 7 -feet above the finished floor.

3.2 FIELD TESTING

Demonstrate emergency lighting units to operate satisfactorily in the presence of the Contracting Officer.

Perform System Operational Tests in accordance with referenced standards in this section.

-- End of Section --

SECTION 26 56 00

EXTERIOR LIGHTING
07/06

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LTS	(2009; Errata 2009) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C136.21	(2004) Roadway Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA HB-9	(2000; Errata 2004; Errata 2005) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2007; Errata 2006 & 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48, 59 2009) National Electrical Safety Code
IEEE Std 100	(2000) The Authoritative Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.42	(2007) Standard for High-Pressure Sodium

	Lamps
NEMA C136.13	(2004; R 2009) Roadway Lighting Equipment, Metal Brackets for Wood Poles
NEMA C136.3	(2005) Roadway and Area Lighting Equipment Luminaire Attachments
NEMA ICS 2	(2000; R 2005; Errata 2008) Standard for Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL 1598	(2008; Rev thru Jan 2010) Luminaires
UL 773	(1995; Rev thru Mar 2002) Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2006) Nonindustrial Photoelectric Switches for Lighting Control

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

c. Groundline section is that portion between one foot above and 2 feet below the groundline.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Energy Efficiency
Luminaires; G
Lamps; G
Ballasts; G
Lighting contactor; G
Lighting Control Panel; G
Photocell switch; G
Steel poles; G
Brackets

SD-10 Operation and Maintenance Data

Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

1.4 QUALITY ASSURANCE

1.4.1 Design Data for Luminaires

a. Distribution data according to IESNA classification type as defined in IESNA HB-9.

b. Computerized horizontal illumination levels in footcandles at ground level, taken every 10 feet. Include average maintained footcandle level and maximum and minimum ratio.

c. Amount of shielding on luminaires.

1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Steel Poles

Do not store poles on ground. Support poles so they are at least one foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

1.6.1 Energy Efficiency

Comply with National Energy Policy Act and Energy Star requirements for lighting products. Submit data indicating lumens per watt efficiency and color rendition index of light source.

1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 OPERATIONAL SERVICE

Coordinate with manufacturer for maintenance agreement. Collect information from the manufacturer about maintenance agreement options, and submit to Contracting Officer.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 26 51 00 INTERIOR LIGHTING.

2.2 LUMINAIRES

UL 1598. Provide luminaires as indicated. Provide luminaires complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness

characteristics, and of equal finish and quality will be acceptable as approved.

2.2.1 Lamps

2.2.1.1 High-Pressure Sodium (HPS) Lamps

NEMA ANSLG C78.42. Wattage as indicated. HPS lamps shall have average rated life of 16,000 hours (minimum) for 35 watt lamps and 24,000 hours (minimum) for all higher wattage lamps. Lamps shall have Luminaire Efficiency Ratings (LER) as follows:

a. Upward efficiency of 0%

    1. 150-399 watts: minimum 58 LER for closed fixture; minimum 68 for open fixture

    2. 400-999 watts: minimum 63 LER for closed fixture; minimum 84 for open fixture

b. Upward efficiency of 1%-10%

    1. 150-399 watts: minimum 64 LER for closed fixture; minimum 63 for open fixture

    2. 400-999 watts: minimum 82 LER for closed fixture; minimum 89 for open fixture

    3. 1000+ watts: minimum 109 LER for open fixture

c. Upward efficiency of 11% to 20%

    1. 150-399 watts: minimum 78 LER for open fixture

    2. 400-999 watts: minimum 94 for open fixture

d. Upward efficiency greater than 20%

    1. 150-399 watts: minimum 75 LER for closed fixture; minimum 77 for open fixture

2.3 LIGHTING CONTACTOR

NEMA ICS 2, electrically held contactor. Contacts shall be rated 277 volts, 20 amperes, and single poles. Coils shall be rated 120 volts. Rate contactor as indicated. Provide in NEMA 1 enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts and shall require no arcing contacts.

2.4 Control Panel

Electronic type control panel, arranged to turn "ON" at sunset, and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Provide control panel with a manual on-off bypass switch. Housing for the control panel shall be surface mounted, NEMA 1 enclosure conforming to NEMA ICS 6.

2.5 PHOTOCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 120 volts ac, 60 Hz with single-throw contacts designed to fail to the ON position. Switch shall turn on at or below 3 footcandles and off at 4 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition. Provide switch:

a. In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.

2.6 POLES

Provide poles designed for wind loading of 120 miles per hour determined in accordance with AASHTO LTS while supporting luminaires and all other appurtenances indicated. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole. Poles shall be anchor-base type designed for use with underground supply conductors. Poles, other than wood poles, shall have oval-shaped handhole having a minimum clear opening of 2.5 by 5 inches. Handhole cover shall be secured by stainless steel captive screws. Metal poles shall have an internal grounding connection accessible from the handhole near the bottom of each pole. Scratched, stained, chipped, or dented poles shall not be installed.

2.6.1 Steel Poles

AASHTO LTS. Provide steel poles having minimum 11-gage steel with minimum yield/strength of 48,000 psi and hot-dipped galvanized in accordance with ASTM A 123/A 123M factory finish. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire. Pole shall be anchor bolt mounted type. Poles shall have tapered tubular members, either round in cross section or polygonal. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings shall be approximately 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, and length. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 36,000 psi.

2.7 BRACKETS AND SUPPORTS

NEMA C136.3, NEMA C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 1 1/4 inch galvanized steel pipe secured to pole. Slip-fitter or pipe-threaded brackets may be used, but brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Brackets for pole-mounted street lights shall correctly position luminaire no lower than mounting height indicated. Mount brackets not less than 24 feet above street. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

2.8 POLE FOUNDATIONS

Anchor bolts shall be steel rod having a minimum yield strength of 50,000 psi; the top 12 inches of the rod shall be galvanized in accordance with ASTM A 153/A 153M. Concrete shall be as specified in Section 03 30 00

CAST-IN-PLACE CONCRETE.

2.9 EQUIPMENT IDENTIFICATION

2.9.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.9.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific lamps and ballasts according to proper lamp type. The following lamp characteristics shall be noted in the format "Use Only _____":

a. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

b. ANSI ballast type (M98, M57, etc.) for HID luminaires.

c. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.10 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Steel Poles

Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Concrete for anchor bases, polyvinyl chloride (PVC) conduit ells, and ground rods shall be as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location.

3.1.2 Pole Setting

Depth shall be as indicated. Poles in straight runs shall be in a straight line. Dig holes large enough to permit the proper use of tampers to the full depth of the hole. Place backfill in the hole in 6 inch maximum layers and thoroughly tamp. Place surplus earth around the pole in a conical shape and pack tightly to drain water away.

3.1.3 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations. Mount switch on or beside each luminaire when switch is provided in cast weatherproof aluminum housing with swivel arm. Set adjustable window slide for 3 footcandles photocell turn-on.

3.1.4 GROUNDING

Ground noncurrent-carrying parts of equipment including metal poles, luminaires, mounting arms, brackets, and metallic enclosures as specified in Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

3.2 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that the equipment operates in accordance with the requirements of this section.

-- End of Section --

SECTION 28 31 76

INTERIOR FIRE ALARM AND MASS NOTIFICATION SYSTEM (READY)
11/08

PART 1 GENERAL

1.1 RELATED SECTIONS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein. In addition, refer to the following sections for related work and coordination:

Section 21 13 13.00 20 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION
Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS.
Section 08 71 00 DOOR HARDWARE for door releasedoor unlocking and additional work related to finish hardware.
Section 07 84 00 FIRESTOPPING for additional work related to firestopping.

1.2 REFERENCES

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

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S3.2	(2009) Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/CC_host/pages/public/custom

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60268-16	(2003) Sound System Equipment - Part 16: Objective Rating Of Speech Intelligibility By Speech Transmission Index; Ed 3.0

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 7240-16	(2007) Fire Detection And Alarm Systems —

	Part 16: Sound System Control And Indicating Equipment

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA-STD-8719.11 Rev. A	(2008) Safety Standard For Fire Protection

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 170	(2009) Standard for Fire Safety and Emergency Symbols
NFPA 70	(2008; TIA 08-1) National Electrical Code
NFPA 72	(2007; TIA 07-1; TIA 07-2) National Fire Alarm and Signaling Code
NFPA 90A	(2009; Errata 09-1) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 1480	(2003; R 2010) Standard for Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
UL 1638	(2001; R thru 2008) Visual Signaling Appliances - Private Mode Emergency and General Utility Signaling
UL 1971	(2002; R thru 2008) Signaling Devices for the Hearing Impaired
UL 2017	(2008; R 2009) General-Purpose Signaling Devices and Systems
UL 268	(2009) Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; R 2009) Smoke Detectors for Duct Application
UL 464	(2009) Standard for Audible Signal Appliances
UL 521	(1999; R thru 2010) Heat Detectors for Fire Protective Signaling Systems
UL 864	(2003; R thru 20109) Standard for Control Units and Accessories for Fire Alarm Systems
UL Electrical Constructn	(2009) Electrical Construction Equipment Directory
UL Fire Prot Dir	(2010) Fire Protection Equipment Directory

1.3 DEFINITIONS

Wherever mentioned in this specification or on the drawings, the equipment, devices, and functions shall be defined as follows:

a. Analog/Addressable System: A system where multiple signals are transmitted via the same conduction path to a remote fire alarm control unit and fire alarm control panel, decoded and separated so that each signal will initiate the specified response.

b. Interface Device: An addressable device that interconnects hard wired systems or devices to an analog/addressable system.

c. Remote Fire Alarm and Mass Notification Control Unit: A control panel, electronically remote from the fire alarm and mass notification control panel, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm control panel.

d. Fire Alarm and Mass Notification Control Panel (FACP/FMCP): A master control panel having the features of a fire alarm and mass notification control unit and fire alarm and mass notification control units are interconnected. The panel has central processing, memory, input and output terminals, printers.

e. Terminal Cabinet: A steel cabinet with locking, hinge-mounted door that terminal strips are securely mounted.

1.4 SYSTEM DESCRIPTION

1.4.1 Scope

a. This work includes completion of design and providing a new, complete, analog/addressable fire alarm and mass notification ready system as described herein and on the contract drawings for the EDM 1703 - Facility Support Center. Include in the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide system complete and ready for operation.

b. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required and advisory provisions of NFPA 72, ISO 7240-16, IEC 60268-16,and NASA-STD-8719.11 REV.A except as modified herein. The system layouts on the drawings show the intent of coverage and are shown in suggested locations. Final quantity, system layout, and coordination are the responsibility of the Contractor. A single fire alarm control panel is indicated.

c. Where remote fire alarm control units are needed, they shall be provided at a terminal cabinet location. Each remote fire alarm control unit shall be powered from a wiring riser specifically for that use or from a local emergency power panel located on the same floor as the

remote fire alarm control unit. Where remote fire control units are provided, equipment for notification appliances may be located in the remote fire alarm control units.

d. The fire alarm system shall be compatible with the existing SimplexGrinnell 4100U fire alarm panel at Post #1.

e. All Mass Notification System devices and power supplies marked (future) on the fire alarm plans shall be offered as an option to the base contract. Only the Mass Notification System wiring run in common conduits with fire alarm wiring and mounting boxes for Mass Notification devices (with covers) shall be installed under this contract.

1.4.2 Technical Data and Computer Software

Technical data and computer software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Identify data delivered by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

a. Identification of programmable portions of system equipment and capabilities.

b. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

c. Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.

d. Description of Fire Alarm Control Panel equipment operation.

e. Description of auxiliary and remote equipment operations.

f. Library of application software.

g. Operation and maintenance manuals.

1.4.3 Keys

Keys and locks for equipment shall be identical. Provide not less than six keys of each type required.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Annotated catalog data, in table format on the drawings, showing

manufacturer's name, model, voltage, and catalog numbers for equipment and components. Submitted shop drawings shall not be smaller than ISO A1.

Wiring Diagrams; G

Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams shall show connections from field devices to the FACP and remote fire alarm control units, initiating circuits, switches, relays and terminals.

Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

System Layout; G

Plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 170 and NASA-STD-8719.11 Rev. A, Fire Safety Symbols.

System Operation; G

A complete list of device addresses and corresponding messages.

Notification Appliances; G

Data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances, 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

Amplifiers; G

Data to indicate that the amplifiers have sufficient capacity to simultaneously drive all notification speakers at the maximum rating plus 50 percent spare capacity. Annotate data for each circuit on the drawings.

As-Built Drawings

Six sets of detailed as-built drawings. Furnish one set of full size paper as-built drawings and schematics. The drawings shall be prepared on uniform sized mylar sheets not less than 30 by 42 inches with 8 by 4 inch title block similar to contract drawings. The drawings shall include complete wiring diagrams showing connections between devices and equipment, both factory and field wired. Include a riser diagram and drawings showing the as-built location of devices and equipment. The drawings shall show the system as installed, including deviations from both the project drawings and the approved shop drawings. These drawings shall be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings shall be

provided at the time of, or prior to the final acceptance test.

SD-03 Product Data

UL or FM listing cards for equipment provided.

Technical Data And Computer Software; G
Fire alarm control panel (FACP); G
Fire Alarm And Mass Notification Control Panel (FACP/FMCP); G
Printers; G
Terminal cabinets/assemblies; G
Manual stations; G
Batteries; G
Battery chargers; G
Smoke sensors; G
Thermal sensors; G
Wiring and cable; G
Notification appliances; G
Addressable interface devices; G
Graphic annunciator; G
Amplifiers; G
Tone generators; G
Digitalized voice generators; G
Waterflow detectors; G
Tamper switches; G
Remote fire alarm control units; G

SD-05 Design Data

System Operation; G

A complete description of the system operation in matrix format on the drawings.

Battery power; G

Battery calculations as required in paragraph Battery Power Calculations.

SD-06 Test Reports

Field Quality Control
Testing Procedures; G
Smoke sensor testing procedures; G

SD-07 Certificates

Installer

SD-09 Manufacturer's Field Reports

Mass Notification System

A unique identifier for each device, including the control panel and initiating and indicating devices, with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information. Include the NFPA 72 Record of Completion and NFPA 72 Inspection and Testing

Form, with the appropriate test reports.

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G

Six copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions shall be a single volume or in separate volumes, and may be submitted as a Technical Data Package. Manuals shall be approved prior to training.

Original and backup copies of all software delivered for this project, on each type of CD/DVD media utilized.

Instruction of Government Employees

The installers training history for the employees involved with this contract.

1.6 QUALITY ASSURANCE

Equipment and devices shall be compatible and operable with existing station fire alarm system and shall not impair reliability or operational functions of existing supervising station fire alarm system.

a. In NFPA publications referred to herein, consider advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; interpret reference to "authority having jurisdiction" to mean the Contracting Offices Designated Representative (COR).

b. The recommended practices stated in the manufacturer's literature or documentation shall be considered as mandatory requirements.

c. Devices and equipment for fire alarm service shall be listed by UL Fire Prot Dir or approved by FM APP GUIDE.

1.6.1 Qualifications

1.6.1.1 Design Services

Installations requiring completion of installation drawings and specification or modifications of fire detection, fire alarm, mass notification system, fire suppression systems or mass notification systems shall require the services and review of a qualified engineer. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

a. A registered professional engineer (P.E.) in fire protection engineering.

1.6.1.2 Supervisor

The installing Contractor shall provide the following: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system/mass notification system. The Fire Alarm technicians supervising the installation of equipment shall be factory trained in the installation,

adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6.1.3 Technician

The installing Contractor shall provide the following: Fire Alarm Technicians with a minimum of four years of experience utilized to assist in the installation and terminate fire alarm/mass notification devices, cabinets and panels. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6.1.4 Installer

The installing Contractor shall provide the following: Fire Alarm installer with a minimum of two years of experience utilized to assist in the installation of fire alarm/mass notification devices, cabinets and panels. An electrician shall be allowed to install wire or cable and to install conduit for the fire alarm system/mass notification system. The Fire Alarm installer shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6.1.5 Test Personnel

The installing Contractor shall provide the following: Fire Alarm Technicians with a minimum of eight years of experience utilized to test and certify the installation of the fire alarm/mass notification devices, cabinets and panels. The Fire Alarm technicians testing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6.1.6 Manufacturer's Representative

The fire alarm and mass notification equipment manufacturer's representative shall be present for the connection of wiring to the control panel. The Manufacturer's Representative shall be an employee of the manufacturer with necessary technical training on the system being installed.

1.6.1.7 Manufacturer

Components shall be of current design and shall be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as otherwise or additionally specified herein.

1.6.2 Regulatory Requirements

1.6.2.1 Requirements for Fire Protection Service

Equipment and material shall have been tested by UL and listed in UL Fire Prot Dir or approved by FM and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, they shall mean listed in UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.

1.6.2.2 Mass Notification System

The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory for the intended use. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.

1.6.2.3 Testing Services or Laboratories

Fire alarm and fire detection equipment shall be constructed in accordance with UL Fire Prot Dir, UL Electrical Constructn, or FM APP GUIDE.

1.7 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.8 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions shall include:

a. "Manufacturer Data Package " as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

b. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features.

c. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

d. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements.

e. Software delivered for this project shall be provided, on each type of CD/DVD media utilized.

f. Printouts of configuration settings for all devices.

g. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

1.9 EXTRA MATERIALS

1.9.1 Repair Service/Replacement Parts

Repair services and replacement parts for the system shall be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During guarantee period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site.

1.9.2 Interchangeable Parts

Spare parts furnished shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts shall be delivered to the Contracting Officer at the time of the final acceptance testing.

1.9.3 Spare Parts

Furnish the following spare parts and accessories:

a. Four fuses for each fused circuit

b. Nine spare reams of paper for the system printer, plus sufficient paper for fire alarm acceptance tests

c. Three spare printer ribbons

1.9.4 Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Standard Products

Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory, such as UL or FM, and listed or approved for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least two years prior to bid opening.

2.1.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:

a. FACPs
b. Printer

Furnish nameplates to obtain approval by the Contracting Officer before installation. Obtain approval by the Contracting Officer for installation locations. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls.

2.2 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment shall be listed for use under the applicable reference standards. Interfacing of Listed UL 864 or similar approved industry listing with Mass Notification Panels listed to UL 2017 or equal shall be done in a laboratory listed configuration, if the software programming features can not provide a listed interface control. If a field modification is needed, such as adding equipment like relays, the manufacturer of the panels being same or different brand from manufacturer shall provide the installing contractor for review and confirmation by the installing contractor. The installing contractor shall, as part of the submittal documents, provide this information.

2.3 SYSTEM OPERATION

The Addressable Interior Fire Alarm and Mass Notification System shall be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864 Ninth Edition, and UL 2017. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. The system may be placed in the alert mode by local micrphones or remotely from authorized locations/users.

2.3.1 Alarm Initiating Devices

Connect alarm initiating devices to initiating device circuits (IDC), Style B to signal line circuits (SLC), Style 4 and installed in accordance with NFPA 72. The system shall have an interconnected riser loop or network having Style 4 supervision for interconnection of other FA/MNS control panels.

a. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Class A in accordance with NFPA 72. A looped conduit system shall be provided so that if the conduit and all conductors within are severed or exposed to fire at any point, all IDC, NAC and SLC will remain functional. Should the design or building layout preclude separation then a fire rated separation shall be provided in accordance with NFPA 72. The return portion of the loop shall be remote from the supply portion of the loop.

b. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until initiating device(s) are reset and the fire alarm control panel is manually reset and restored to normal. The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center). Audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system/mass notification system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc.

2.3.2 Functions and Operating Features

The system shall provide the following functions and operating features:

a. The FACP/FMCP and fire alarm and mass notification control units, if used, shall provide power, annunciation, supervision, and control for the system. Addressable systems shall be microcomputer

(microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

b. Provide class A circuits for all Initiating, Signal Line and Notification Appliance Circuits.

c. Provide Class A notification appliance circuits. The visual alarm notification appliances shall have the flash rates synchronized.

d. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.

e. Provide an audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal shall also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory panel modules. Provide a trouble alarm silence feature that shall silence the audible trouble signal, without affecting the visual indicator. After the system returns to normal operating conditions, the trouble signal shall again sound until the trouble is acknowledged. A smoke sensor in the process of being verified for the actual presence of smoke shall not initiate a trouble condition.

f. Provide a notification appliance silencing switch, that when activated, will silence the audible signal appliance, but will not affect the visual alarm indicator, the liquid crystal display, or the automatic notification of the fire department. This switch shall be overridden upon activation of a subsequent alarm.

g. Provide alarm verification capability for smoke sensors. Alarm verification shall initially be set for 30 seconds.

h. Provide program capability via switches in a locked portion of the FACP to bypass the automatic notification appliance circuits, fire reporting systemair handler shutdowndoor release features. Operation of this programming shall indicate this action on the FACP display and printer output.

i. Alarm, supervisory, and/or trouble signals shall be automatically transmitted to the fire department.

j. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

k. The system shall be capable of being programmed from the panels keyboard. Programmed information shall be stored in non-volatile memory.

l. The system shall be capable of operating, supervising, and/or monitoring both addressable and non-addressable alarm and supervisory devices.

m. There shall be no limit, other than maximum system capacity, as to the number of addressable devices, that may be in alarm simultaneously.

n. Where the fire alarm system is responsible for initiating an action in another emergency control device or system, such as an HVAC system, the addressable fire alarm relay shall be within 3 feet of the emergency control device.

o. An alarm signal shall automatically initiate the following functions:

(1) Transmission of an alarm signal to the base fire department.

(2) Visual indication of the device operated on the fire alarm control panel (FACP). Indication on the graphic annunciator shall be by floor, zone or circuit, and type of device.

(3) Recording of the event via the system printer and electronicly in the history log of the fire control system unit.

(4) Release of power to electric locks on doors that are part of the means of egress.

(5) Operation of a duct smoke sensor shall shut down the appropriate air handler in accordance with NFPA 90A in addition to other requirements of this paragraph.

p. A supervisory signal shall automatically initiate the following functions:

(1) Visual indication of the device operated on the FACP, and sound the audible alarm at the respective panel.

(2) Transmission of a supervisory signal to the base fire department.

(3) Recording of the event via the system printer and electronicly in the history log of the fire control system unit.

q. A trouble condition shall automatically initiate the following functions:

(1) Visual indication of the system trouble on the FACP,and sound the audible alarm at the respective panel.

(2) Transmission of a trouble signal to the fire base department.

(3) Recording of the event via the system printer.

r. The maximum permissible elapsed time between the actuation of an initiating device and its indication at the FACP shall be 10 seconds.

s. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP shall not exceed 200 seconds.

2.4 SYSTEM MONITORING

2.4.1 Valves

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, valves at fire pumps, isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, shall be electrically monitored to ensure its proper position. Each tamper switch shall be provided with a separate address, unless they are within the same

room, then a maximum of five can use the same address.

2.5 MASS NOTIFICATION SYSTEM FUNCTIONS

2.5.1 Notification Appliance Network

The notification appliance network consists of audio speakers located to provide intelligible instructions at all locations in the building areas as indicated on the drawings. The Mass Notification System announcements shall take priority over all other function of the system including the audible and visual output of the fire alarm system in a normal or alarm state. All fire alarm system functions shall continue in an alarm state except for the output signals of the audible and visual notification appliances.

2.5.2 Strobes

Strobes are also provided to alert hearing-impaired occupants.

2.5.3 Door Operation

Closure of doors held open by electromagnetic devices.

2.5.4 Voice Notification

An autonomous voice notification control unit is used to monitor and control the notification appliance network and provide consoles for local operation. Using a console, personnel in the building can initiate delivery of pre-recorded voice messages, provide live voice messages and instructions, and initiate visual strobe and (optional) textual message notification appliances. The autonomous voice notification control unit will temporarily override audible fire alarm notification while delivering Mass Notification messages to ensure they are intelligible.

2.5.5 Base-Wide Control

If a base-wide control system for mass notification exists on the base, the autonomous control unit shall communicates with the central control unit of the base-wide system. The autonomous control unit shall receive commands/messages from the central control unit and provide status information.

2.6 OVERVOLTAGE AND SURGE PROTECTION

2.6.1 Signaling Line Circuit Surge Protection

For systems having circuits located outdoors, communications equipment shall be protected against surges induced on any signaling line circuit and shall comply with the applicable requirements of IEEE C62.41.1 and IEEE C62.41.2. Cables and conductors, that serve as communications links, shall have surge protection circuits installed at each end that meet the following waveform(s):

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Protection shall be provided at the equipment. Additional triple electrode gas surge protectors, rated for the application, shall be installed on each

wireline circuit within 3 feet of the building cable entrance. Fuses shall not be used for surge protection.

2.6.2 Sensor Wiring Surge Protection

Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested with the following waveforms:

a. A 10 by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

2.7 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored shall be configured as a Style B initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation, etc. The module shall be UL or FM listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled. Pull stations with a monitor module in a common backbox are not required to have an LED.

2.8 ADDRESSABLE CONTROL MODULE

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders or initiate elevator fire service. The module shall be UL or FM listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Style Y notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled. Control Modules shall be located in environmental areas that reflect the conditions to which they were listed.

2.9 SMOKE SENSORS

2.9.1 Photoelectric Smoke Sensors

Provide addressable photoelectric smoke sensors as follows:

a. Provide analog/addressable photoelectric smoke sensors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke sensors shall be listed for use with the fire alarm control panel.

b. Provide self-restoring type sensors that do not require any readjustment after actuation at the FACP to restore them to normal operation. Sensors shall be UL listed as smoke-automatic fire sensors.

c. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.

d. Provide twist lock bases for the sensors. The sensors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.

e. The sensor address shall identify the particular unit, its location within the system, and its sensitivity setting. Sensors shall be of the low voltage type rated for use on a 24 VDC system.

f. An operator at the control panel, having a proper access level, shall have the capability to manually access the following information for each initiating device.

(1) Primary status

(2) Device type

(3) Present average value

(4) Present sensitivity selected

(5) Sensor range (normal, dirty, etc.)

2.9.2 Projected Beam Smoke Detectors

Detectors shall be designed for detection of abnormal smoke densities. Detectors shall consist of separate transmitter and receiver units. The transmitter unit shall emit an infrared beam to the receiver unit. When the signal at the receiver falls below a preset sensitivity, the detector shall initiate an alarm. The receiver shall contain an LED that is powered upon an alarm condition. Long-term changes to the received signal caused by environmental variations shall be automatically compensated. Detectors shall incorporate features to assure that they are operational; a trouble signal shall be initiated if the beam is obstructed, the limits of the compensation circuit are reached, or the housing cover is removed. Detectors shall have multiple sensitivity settings in order to meet UL listings for the different distances covered by the beam. In the event of beam interference for more than three seconds a trouble alarm shall be transmitted.

2.9.3 Duct Smoke Sensors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors

shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm panel.

a. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel.

b. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 6 feet and those mounted below 6 feet that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches.

c. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in Section 23 09 23.13 20 BACnet DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC. Auxiliary contacts provide for this function shall be located within 3 feet of the controlled circuit or appliance. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.9.4 Smoke Sensor Testing

Smoke sensors shall be tested in accordance with NFPA 72 and manufacturer's recommended calibrated test method. Submit smoke sensor testing procedures for approval.

2.10 THERMAL SENSORS

2.10.1 Heat Detectors

Heat detectors shall be designed for detection of fire by combination fixed temperature and rate-of-rise principle rate-compensating principle. The alarm condition shall be determined by comparing sensor valve with the stored values. Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, shall be types approved for such locations.

2.10.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors shall be designed for surface outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication that is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 feet.

2.10.1.2 Fixed Temperature Detectors

Detectors shall be designed for surface outlet box mounting and supported

independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of 135 degrees F. The UL 521 test rating for the fixed temperature detectors shall be rated for 15 by 15 feet.

2.10.2 Heat Sensing

A moving average of the sensors heat sensing value to automatically compensate for conditions that could affect detection operations. System shall automatically maintain a constant heat sensing sensitivity from each sensor by compensating for environmental factors.

2.10.3 Self-Test Routines

Automatic self-test routines shall be performed on each sensor that will functionally check sensor sensitivity electronics and ensure the accuracy of the value being transmitted. Any sensor that fails this test shall indicate a trouble condition with the sensor location at the control panel.

2.10.4 Operator Access

An operator at the control panel, having the proper access level, shall have the capability to manually access the following information for each heat sensor:

a. Primary status

b. Device type

c. Present average value

d. Sensor range

2.10.5 Operator Control

An operator at the control panel, having the proper access level, shall have the capability to manually control the following information for each heat sensor:

a. Alarm detection sensitivity values

b. Enable or disable the point/device

c. Control sensors relay driver output

2.11 EMERGENCY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm.

2.11.1 Batteries

Provide sealed, maintenance-free, batteries as the source for emergency power to the FACP. Batteries shall contain suspended electrolyte. The battery system shall be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary

power.

2.11.1.1 Capacity

Provide the batteries with sufficient capacity to operate the system under supervisory and trouble conditions, including audible trouble signal devices for 72 hours and audible and visual signal devices under alarm conditions for an additional 15 minutes.

2.11.1.2 Battery Power Calculations

a. Verify that battery capacity exceeds supervisory and alarm power requirements.

1). Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Ampere-hour requirements for each system component and each panel component, and the battery-recharging period shall be included.

2). Provide complete battery calculations for both the alarm, alert, and supervisory power requirements. Ampere-hour requirements for each system component shall be submitted with the calculations.

3). A voltage drop calculation to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries.

b. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using this voltage perform a voltage drop calculation for circuit containing device and/or appliances remote from the power sources.

2.11.2 Battery Chargers

Provide a solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 150 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged (18 Volts dc), the charger shall recharge the batteries back to 95 percent of full charge within 48 hours. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.12 FIRE ALARM AND MASS NOTIFICATION CONTROL PANEL (FACP/FMCP)

Provide a complete control panel fully enclosed in a lockable steel enclosure as specified herein. Operations required for testing or for normal care and maintenance of the systems shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control panel, the unit enclosures shall match exactly.

a. Each control unit shall provide power, supervision, control, and

logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each panel with supervisory functions for power failure, internal component placement, and operation.

b. Visual indication of alarm, supervisory, or trouble initiation on the fire alarm control panel shall be by liquid crystal display or similar means with a minimum of 80 characters, that at least 32 are field changeable. The MNS Control panel shall have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages. Provide conductor integrity monitoring for strobe, display, temporary deactivation of fire alarm audible notification appliances and speaker wiring.

c. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least four pre-recorded messages. Provide the ability to automatically repeat pre-recorded messages. Provide a secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, and initiate/synchronize strobes. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file.

2.12.1 Cabinet

Install control panel components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of panels as well as field wiring. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall say "Fire Alarm and Mass Notification Control Panel" and shall not be less than one inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.

2.12.2 Control Modules

Provide power and control modules to perform all functions of the FACP. Provide audible signals to indicate any alarm, supervisory, or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and relays, if any, on screw terminals in the FACP. Circuits operating at 24 VDC shall not operate at less than 21.6 volts. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.

2.12.3 Silencing Switches

a. Alarm Silencing Switch: Provide an alarm silencing switch at the FACP that shall silence the audible signal but not affect the visual alarm indicator. This switch shall be overridden upon activation of a subsequent alarm.

b. Supervisory/Trouble Silencing Switch: Provide supervisory and trouble silencing switch that shall silence the audible trouble and

supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent alarm, supervision, or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

2.12.4 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually reset by switch from the FACP after the initiating device or devices have been restored to normal.

2.12.5 Voice Notification System

The Voice Notification System shall comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements ISO 7240-16, IEC 60268-16, except as specified herein. The system shall be a one-way multi-channel voice notification system incorporating user selectability of a minimum 8 distinct sounds for tone signaling, and the incorporation of a voice module for delivery of prerecorded messages. Automatic messages shall be broadcast through speakers on appropriate floors. The visual strobes and audible message shall automatically be broadcast on the floor of fire alarm origin, the floor immediately above the floor of fire alarm origin, and the floor immediately below the floor of fire alarm origin. A live voice message shall override the automatic audible output through use of a microphone input at the control panel.

a. When using the microphone, live messages shall be broadcast through speakers in stairs, and throughout a selected floor or floors. The system shall be capable of operating all speakers at the same time. The digitalized voice message shall consist of a non-volatile (EPROM) microprocessor based input to the amplifiers. The microprocessor shall actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative shall automatically cause the slow whoop tone to take over all functions assigned to the failed unit.

b. The Mass Notification functions shall override the manual or automatic fire alarm notification or Public Address (PA) functions. The system shall have the capability of utilizing a remote microphone station with redundant controls of the notification system control panel. Class "B" Notification Appliance Circuits (NAC) shall be provided for the activation of strobe appliances. The activation of the NAC Circuits shall follow the operation of the speaker NAC circuits. Audio output shall be selectable for line level (600 ohms), 25, 70.7 or 100 volt output. The audio amplifier outputs shall be not greater than 100 watts RMS output. The strobe NAC Circuits shall provide at least 2 amps of 24 VDC power to operate strobes and have the ability to synchronize all strobes. A hand held microphone shall be provided and, upon activation, shall take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC Circuits activation.

All outputs and operational modules shall be fully supervised with on-board diagnostics and trouble reporting circuits. Form "C" contacts shall be provided for system alarm and trouble conditions. Circuits shall be

provided for operation of auxiliary appliance during trouble conditions. During a Mass Notification event the panel shall not generate nor cause any trouble alarms to be generated with the Fire Alarm system. Same panel with the fire alarm system. Mass Notification functions shall take precedence over all other function performed by the Voice Notification System. Messages shall utilize a female voice and shall be similar to the following:

1) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"May I have your attention, please. May I have your attention, please. A fire has been reported that may affect your floor. Please walk to the nearest exit and evacuate the building." (Provide a 2 second pause.) "May I have your attention, please, (repeat the message)."

2) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"May I have your attention please. May I have your attention please. A fire emergency has been reported in the building. Please leave the building by the nearest exit or exit stairway. Do not use the elevators." (Provide a 2 second pause.) "May I have your attention please, (repeat the message)."

3) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert! This is the Mass Notification System.
There is an emergency situation.
DO NOT evacuate the building! Stay in your current location!
Stay tuned for further instructions."
(repeat message 2 times)

4) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert, This is the Mass Notification System.
There is a chemical gas emergency.
Turn off all HVAC equipment, seal all doors and windows with wet fabric, Don protective gear.
DO NOT evacuate the building, Act now!
Listen to the MNS system for further instructions".
(repeat message 2 times)

5) 1000 Hz tones (1 sec on, 1/2 second off, 1 second on, 1/2 second off, 1 second on)

"Alert, this is the Mass Notification System.
There is a explosive blast risk along the South wall of your building.
Quietly move towards the north side of the building, and exit from the north stairs.
Move away from the building heading north to the north parking area.
(repeat message 2 times).

a. The Remote Microphone station shall incorporate a Push-To-Talk (PTT) microphone, redundant controls and system status indicators

of/for the system. The unit shall incorporate microphone override of any tone generation or prerecorded messages. The unit shall be fully supervised from the control panel. The housing shall contain a lock that is keyed identical to the fire alarm system for the building.

b. Auxiliary Input Module shall be designed to be an outboard expansion module to either expand the number of optional remote microphone stations, or allow a telephone interface.

c. Remote Microphone station (PA) shall incorporate a Push-To-Talk (PTT) microphone, and controls to allow Public Address paging in the facility. The Public Address paging function shall not override any alarm or notification functions. The microphone shall be handheld style.

2.12.6 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.12.7 Field Programmability

Provide control units and control panels that are fully field programmable for control, initiation, notification, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer based equipment.

2.12.8 Input/Output Modifications

The FACP shall contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features shall consist of a panel mounted keypad. Any bypass or modification to the system shall indicate a trouble condition on the FACP and a printed output of the trouble condition.

2.12.9 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists.

2.12.10 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the instructions on the interior of the FACP.Install the frame in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by the Contracting Officer before being posted.

2.12.11 Walk Test

The FACP shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is

indicated on the system printer, but no other outputs occur.

2.12.12 History Logging

In addition to the required printer output, the control panel shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory.

2.12.13 RS-232-C Output

Each local control panel shall be capable of operating remote service type cathode ray tubes (CRTs), printers, and/or modems. The output shall be paralleled ASCII from an EIA RS-232-C connection with a baud rate of 1200 or 2400 to allow use of any commonly available CRT, printer, or modem.

2.12.14 Remote LED Text Display

An LED text display shall be provided at locations as shown on the drawings. The LED text display shall be at least 2 lines with a minimum of 20 characters per line. The size shall not exceed 16 inches length by 6 inches height by 3 inches deep. The text display shall as a minimum meet the following requirements:

a. Two lines of information for high priority messaging.

b. Minimum of 20 characters per line (40 total) displayed.

c. Text shall be no less than 1/2 inch in height and readable from 1 foot to 20 feet away.

d. 32K character memory.

e. RS232 or RS485 serial interface included.

f. Display shall be wall or ceiling mounted.

g. Mounting brackets for a convenient wall/cubicle mount.

h. During non-emergency periods, date and time shall be displayed.

i. All programming shall be accomplished from the Mass Notification network. No user programming shall be required.

An LED text display shall be provided at locations as shown on the drawings. The LED text display shall have minimum character size of 4-inches high and shall spell out the words "EVACUATE" and "ANNOUNCEMENT". The design of LED text display shall be such that it cannot be read when not illuminated. The LED text display shall be capable of being wall or ceiling mounted.

2.13 REMOTE FIRE ALARM CONTROL UNITS

Provide complete remote control units fully enclosed in a lockable steel enclosure as specified herein. Operations required for testing or for normal care and maintenance of the control units shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control panel, the unit enclosures shall match

exactly. Each control unit shall provide power, supervision, control, and logic for its portion of the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each unit with supervisory functions for power failure, internal component placement, and operation.

2.13.1 Cabinet

Install remote control unit components in cabinets large enough to accommodate components and also to allow ample gutter space for interconnection of units as well as field wiring. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall be labeled "Remote Fire Alarm Control Unit" and shall not be less than one inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.

2.13.2 Control Modules

Provide power and control modules to perform all functions of the remote control unit. Provide audible signals to indicate any alarm or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and relays, if any, on screw terminals in the remote control unit. Circuits operating at 24 VDC shall not operate at less than 21.6 volts. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage. Circuits shall be arranged so that there is 25 percent spare capacity for any circuit.

2.13.3 Silencing Switches

Provide an alarm silencing switch at the remote control unit that shall silence the audible signal but not affect the visual alarm indicator. This switch shall be overridden upon activation of a subsequent alarm. Provide trouble and supervisory silencing switch that shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent trouble or supervisory signal. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

2.13.4 Non-Interfering

Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually resettable by switch from the remote control unit after the initiating device or devices have been restored to normal.

2.13.5 Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS.

2.13.6 Field Programmability

Provide control units that are fully field programmable for control, initiating, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer based equipment.

2.13.7 Input/Output Modifications

Each remote control unit shall contain features that allow the elimination of input devices from the system or the modification of system outputs. Any such modifications shall indicate a trouble condition on the remote control unit, the FACP, and a printed output of the trouble condition.

2.13.8 Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory, or trouble condition on the system still exists.

2.13.9 Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the remote fire alarm control unit. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by the Contracting Officer before being posted.

2.13.10 Walk Test

Each remote control unit shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur.

2.13.11 History Logging

In addition to the required printer output, the control panel shall have the ability to store a minimum of 4000 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory.

2.14 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 shall be housed in a fire alarm control unit, terminal cabinet, or in the fire alarm control panel. The system shall automatically operate and control all building fire alarm speakers except those installed in the stairs and within elevator cabs. The speakers in the stairs and elevator cabs shall operate only when the microphone is used to deliver live messages. Each amplifier shall be single output channel.

2.14.1 Construction

Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

2.14.2 Inputs

Each system shall be equipped with separate inputs from the tone generator, digitalized voice driver and panel mounted microphone. Microphone inputs shall be of the low impedance, balanced line type. Both microphone and tone generator input shall be operational on any amplifier.

2.14.3 Tone Generator

The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a slow whoop tone, that shall slowly ascend from low (500 hertz) to high (1200 hertz), and shall be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. Each slow whoop cycle shall last approximately 4 seconds. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

2.14.4 Protection Circuits

Each amplifier shall be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate logging of the condition on the system printer, and other actions for trouble conditions as specified.

2.15 SYSTEM PRINTERS

a. Provide a system printer to record alarm, supervisory, and trouble conditions without loss of any signal or signals. Printout shall be by circuit, device, and function as provided in the FACP. Printer shall operate on a 120 VAC, 60 Hz power supply. The printer shall have at least 80 characters per line and have a 96 ASCII character set. The printer shall have a microprocessor-controlled, bi-directional, logic seeking head capable of printing 120 characters per second. Printer shall not contain internal software that is essential for proper operation.

b. When the FACP receives a signal, the alarm, supervisory, and trouble condition shall be printed. The printout shall include the type of signal, the circuit or device reporting, the date, and the time of the occurrence. The printer shall differentiate alarm signals from other printed indications. When the system is reset, this condition shall also be printed including the same information concerning device, location, date, and time. Provide a means to automatically print a list of existing alarm, supervisory, and trouble conditions in the system. If a printer is off-line when an alarm is received, the system shall

have a buffer to retain the data and it shall be printed when the printer is restored to service. The printer shall have an indicator to alert the operator that the paper has run out.

2.16 MANUAL STATIONS

Provide metal or plastic, semi-flush mounted, dual action push pull type, addressable manual stations, that are not subject to operation by jarring or vibration. Stations shall be equipped with screw terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations shall be finished in fire-engine red with molded raised lettering operating instructions of contrasting color. The use of a key or wrench shall be required to reset the station. Manual stations shall be mounted at 48 to 54 inches. Stations shall have a separate screw terminal for each conductor.

2.17 NOTIFICATION APPLIANCES

2.17.1 Fire Alarm/Mass Notification Speakers

Audible appliances shall conform to the applicable requirements of UL 464. Appliances shall be connected into notification appliance circuits. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted red or white. Recessed audible appliances shall be installed with a grill that is painted red or whitewith a factory finish to match the surface to which it is mounted.

a. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 100 Vac, 70 Vac, 7 Vac, and 25 Vac, by means of selectable tap settings. Tap settings shall include taps of 1/4, 1/2, 1, 2, and 8 watt. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 400Hz to 4000Hz, and shall have a sealed back construction. Speakers shall be capable of installation on standard 4 inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single wall or ceiling mounted unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the Fire Alarm Control Panel and Voice Notification System.

b. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gauge and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.

2.17.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and conform to the Americans With Disabilities Act (ADA). Colored lens such as amber, the notifications appliances shall comply with UL 1638. The manufacturer shall have the color lens tests to the full UL 1971 polar plotting criteria, voltage drop, and temperature rise as stated in 1971. Fire Alarm Notification Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light and be marked "Fire" in red letters.Fire Alarm/Mass Notification Appliances shall have amber high intensity optic lens, xenon flash tubes, and output white