Technical Specification

Section 16014

Vibration Equipment for Electrical Systems

PART 1 -- GENERAL

2.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install vibration control devices, materials, and related items for electrical systems.

2.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specification and related Contract Documents to establish the total requirements for the referenced vibration isolation.
1. Section 16010 - Basic Electrical Requirements.

2.3 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of vibration-isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

B. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.

C. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

E. Should any electrical equipment cause excessive noise or vibration, the contractor shall be responsible for remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

F. Upon completion of the Work, the Owner shall inspect the installation and shall inform the contractor of any further work that must be completed. Make all adjustments as directed by the Owner that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

2.4 SUBMITTALS

A. Provide the following in addition to the standard requirements with the Bid. The shop drawing submittal for isolated electrical equipment shall include submittal information for the isolation mounts. Information supplied shall be as follows:
1. A complete description of products to be supplied, including product data, dimensions, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:
a. The equipment identification mark.
b. The isolator type.
3. The actual load.

B. Samples shall be submitted for each type of vibration-isolation device. After approval, samples will be returned for installation at the job. All costs associated with submission of samples shall be borne by the ~~Sub~~contractor.

PART 2 -- PRODUCTS

2.1 VIBRATION-ISOLATION MOUNT TYPES

A. Unit Double Neoprene Pad (DNP):

1. Neoprene pad isolators shall be formed by two layers of 1/4-inch to 3/8-inch-thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. These layers shall be permanently adhered together. Neoprene shall be 40 to 50 durometer. The pads shall be sized so that they will be loaded within the manufacturer's recommended range. A steel top plate equal to the size of the pad shall be provided to transfer the weight of the supported unit to the pads and to distribute the load evenly over the surface of the pads.
2. Unit DNP isolators shall be formed from one of the following products:
   a. Type NR: Amber/Booth.
   b. Type Korpad: Korfund Dynamics.
   c. Type WSW: Mason Industries.
   d. Type NPS: Peabody Noise Control.
   e. Series Shear Flex: Vibration Mountings & Control.

B. Unit Hanger Neoprene or Glass Fiber (HN):
1. Vibration-isolation hangers shall consist of a neoprene-in-shear or glass fiber element contained in a steel housing. A neoprene neck bushing (or other element) shall be provided where the hanger rod passes through the hanger housing to prevent the rod from contacting the hanger housing. The diameter of the hole in the housing shall be sufficient to permit the hanger rod to swing through a 30-degree arc before contacting the hanger housing.

2. Unit HN isolators shall be one of the following products:
   a. Type BRD-A: Amber/Booth.
   b. Type H: Korfund Dynamics.
   c. Type HD: Mason Industries.
   d. Type RH or FH: Peabody Noise Control.
   e. Type RHD or RFD: Vibration Mountings & Control.

2.2 FLEXIBLE ELECTRICAL CONNECTIONS

A. Type A:
1. Flexible electrical connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
2. Flexible electrical connection Type A shall be Crouse-Hinds (Syracuse, New York) "XD Expansion/Deflection Coupling", or Spring City Electrical Mfg. Company (Spring City, Pennsylvania) "Type DF Expansion and Deflection Fitting".

B. Type B: Flexible electrical connection Type B shall be field fabricated using a minimum 24-inch length of liquidtight, flexible metal conduit or cable.

C. Type C: Flexible electrical connection Type C shall be field fabricated using a minimum 48-inch length of liquidtight flexible metal conduit or cable.

PART 3 -- EXECUTION

3.1 APPLICATION

A. Transformers, Unit Substations,Main Swithgear and Engine Generators:
1. Transformers within the building construction shall be mounted on unit DNP isolators. Where the transformer is part of a unit substation and the transformer cabinet is directly connected to switchgear cabinets, the entire unit substation assembly and main switchgear shall be mounted on unit DNP isolators. If the transformers are suspended, use unit HN isolators selected to achieve not less than 0.10 inch static deflection.
2. Electrical connections to isolated transformers and unit substations shall be made using flexible electrical connections. Connections made with conduits less than 1 inch shall be Type A or Type B; for conduits sized 1 inch and larger, use Type A.

B. Dimmers: Dimmer cabinets shall be mounted on unit DNP isolators.

C. Mechanical Equipment: Electrical connections to vibration isolated mechanical equipment shall be made using flexible electrical connections. Connections made with conduits less than 1 inch shall be Type A or Type C; for conduits sized 1 inch and larger, use Type A.

3.2 INSTALLATION

A. General: In all cases, isolated electrical equipment shall be positioned so that it is freestanding and does not contact the building structure or other systems.

B. Isolation Mounts:
1. All mounts shall be aligned squarely above or below mounting points for the supported equipment.
2. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
3. Hanger rods for vibration isolated support shall be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
4. Vibration-isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, so the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.

C. Flexible Electrical Connections:
1. Type C connections shall be installed in a grossly slack "U" shape or a 360-degree loop.
2. The flexible coupling or conduit shall not be tied to the building structure or other rigid material beyond the point where it takes off from the rigid conduit.

END OF SECTION

Technical Specification

Section 16121

Medium Voltage Cable & Accessories

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Medium voltage 15-kV cable and accessories.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for medium-voltage cable and accessories:
1. Section 16010 - Basic Electrical Requirements.

1.3 REFERENCES

A. ANSI/IEEE C2 - National Electric Safety Code

B. IEEE 48 - Test Procedures and Requirements for High-Voltage Alternating Current Cable Terminations

C. NEMA WC8 - Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

D. UL 1072 - Medium Voltage Power Cables

E. International Electrotechnical Commission(IEC)

F. NFPA 70 - National Electrical Code (NEC).

1.2 REGULATORY REQUIREMENTS

A. Conform to ANSI/IEEE C2.

B. Cables and conductors shall be listed by Underwriters Laboratories, Inc., as meeting the requirements for the use as described in this specification.

PART 2 -- PRODUCTS

3.1 ACCEPTABLE MANUFACTURERS

A. Okonite.

B. Rome.

3.2 GENERAL

A. Cable shall bear a tag containing name of manufacturer, NEC designation, and year and month of manufacture.

B. Cable to be furnished in continuous lengths and shall be free of kinks and defects at time of delivery to jobsite.

C. The cables will be pulled in conduits or ducts.

D. Sizes, lengths and other specific requirements of the cables shall be as indicated on the Purchase Order or on the drawings.

3.3 SINGLE CONDUCTOR 15KV CABLE

A. All cables shall be suitable for wet or dry locations, terminated with stress cones suitable to the voltage class, and installed by personnel certified and licensed for 15kv class work.

B. Cable: insulated cable rated 15 kV as indicated.

C. Conductor: Size as specified on drawings, copper concentric, stranded with conductor shield, Class B, annealed.

D. Insulation: triple extrusion of semiconducting strand screen, 220 mils minimum ethylene propylene rubber *(EPR)* insulation (133 percent level), semiconducting insulation screen, uncoated 5 mil. bare copper shielding tape with nominal 12 1/2 percent overlap. Jacket: Polyvinylchloride (PVC), 80 mils minimum. UL listing at Type MV-90. Continuous wet or dry operation temperature of 90 degrees C. Continuous wet or dry operation temperature of 90 degrees C.

3.4 FACTORY TESTS

A. Standard Tests: Provide certified test reports of all applicable tests on cable furnished per AEIC 5 and ICEA to the Owner at the time of delivery of the cable to the jobsite. When in conflict, the more stringent test shall apply. Provide samples for Owner sample tests.

3.5 ACCEPTABLE MANUFACTURERS - CABLE TERMINATIONS

A. 3M.

B. Raychem.

C. Elastimold.

3.6 CABLE TERMINATIONS

A. 15 kV Modular Molded Rubber Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including stress cone, ground clamp, nontracking rubber skirts, connector, rubber cap, and serial lug.

B. Cast epoxy Cable Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including stress cone, shield ground connection, wet porcelain rain shield for outdoor units, epoxy resin molding material, and accessories and molds necessary for proper application.

C. Potheads: IEEE 48; Class 1 termination for one conductor with porcelain insulators, cable connector and aerial lug, sealed cable entrance and support, and insulating compound.

D. Porcelain Insulator Cable Terminators: IEEE 48; Class 1. Kit form, suitable for use with cable specified.

3.7 ACCEPTABLE MANUFACTURERS - CABLE SPLICES/TAPS

A. Elastimold.

B. 3M.

3.8 CABLE SPLICES/TAPS

A. Modular Molded Rubber Separable Connectors: Shielded 600-amp insulated connector system rated for continuous operations at 15 kV and 90 degrees C, with emergency overload temperature rating of 130 degrees C. The system components shall be designed and tested in accordance with the specifications listed in ANSI/IEEE Standard 386 for 15-kV 600-amp deadbreak connectors. The system shall consist of components as shown on the Drawings. The system shall accommodate the 15-kV shielded cable sizes shown on the Drawings.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify that conduit is ready to receive work. Use mandrel to determine if installed conduit is suitable for use.

B. Verify field measurements are as shown on the Drawings.

C. Beginning of installation means the Subcontractor accepts existing conditions.

3.2 QUALITY ASSURANCE

A. Contractor: Company specializing in installation of medium voltage cable with minimum three years documented experience.

3.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Attachment IV, Special Terms.

3.4 Contractor shall store and protect products under provisions of Contract Document-Special Terms.

A. Contractor shall accept cable and accessories on-site in manufacturer's packages and inspect for damage.

B. Contractor shall protect cable and accessories from weather by covering with opaque plastic or canvas; provide ventilation to prevent condensation.

3.5 PREPARATION

A. Thoroughly swab conduits to remove foreign material before pulling cables.

3.6 INSTALLATION

A. Install cable and terminations in accordance with manufacturer's instructions and to ANSI/IEEE C2.

B. Ground cable shield at each termination and splice unless noted otherwise on the drawings.

C. Pull cables using suitable lubricants (polywater Type J or F) and cable pulling equipment. Submit to the Owner prior to cable installation calculations that indicate the maximum pulling tension of the cable will not be exceeded. Do not exceed cable pulling tensions and bending radius recommended by manufacturer. Cable pull setup shall be approved by the Owner for each pull. Cable pulls shall be witnessed by the Owner. Back pulls are not permitted.

D. Install cable in manholes along those walls providing the longest route and most spare cable lengths. Arrange cable to avoid interferences with duct entrances into manhole.

E. Avoid abrasion and other damage to cables during installation.

F. Fireproof cables in manholes using Scotch Brand 77 fireproofing tape and Scotch Brand 27 or 69 glass electrical tape in half-lapped wrapping extended 1 inch into ducts.

G. All splices and terminations shall be made with materials as recommended by the cable manufacturer and approved by the Construction Manager's representative before being jacketed or inserted into the stress cones. Prefabricated stress cone kits as specified by cable manufacturer shall be used.

H. Provide terminals and connectors acceptable for the type of conductor used.

I. Accurately record exact sizes and locations of cables.

J. Primary cables shall not at any time be subjected to a bending radius of less than 14 times the overall diameter of cable as per NEMA WC-8 Standard.

K. Cables shall be phased. Each cable shall be labeled as to phase at each end of cable, at each pull or splice box, and at each termination. Absolute care shall be taken to maintain phase rotation (connection) configuration at all transformer primary connections.

L. Cables shall be permanently numbered with feeder designation at each termination, and shall be approved by the owner.

M. At the conduit entrances at the transformer primary and switch cubicles, provide cable supports to relieve the cable strain on the stress cones.

3.7 FIELD QUALITY CONTROL

A. Test medium-voltage cable and accessories in accordance with the requirements of Section 16972, Startup Testing and Commissioning of Electrical Equipment.

B. Strain gauges (dynamometers) shall be utilized on all high voltage cable pulls to ensure that the maximum cable tension is not exceeded. Construction Manager's representative shall be notified prior to all cable pulls and the maximum strain recorded. The contractor shall submit the method for translating the dynamometer reading to actual pulling tension.

3.8 PREPARATION FOR SHIPMENT (Manufacturer)

A. Preparation for shipment shall be in accordance with Seller's standard practice.

B. Seller shall be solely responsible for adequacy of the preparation for shipment provisions to ensure that the cable reaches its destination in ex-works condition.

C. Seller shall submit details of the preparation for shipment provisions along with the quotation.

D. Cable shall be furnished in one continuous length per reel.

E. Each end of the cable shall be provided with a water tight seal to prevent entrance of moisture during transit or storage outdoors.

F. The inner end of the cable shall project through the reel so that the cable can be tested while on the reel at the job site.

G. Each end of the cable shall be firmly and properly secured to the reel to prevent damage during handling and shipment. Care shall be taken to prevent looseness of cable on the reel.

H. The reels shall be lagged or covered with suitable material and strapped to protect the cable from injury during transit, storage and handling.

I. Cables shall be factory tested to ensure that they have been manufactured in accordance with this specification and the applicable standards. Certified test reports shall be furnished to Construction Manager.

END OF SECTION

M. Primary Terminations: air-filled compartment. Bushings shall be porcelain or cast resin epoxy side mounted on opposite side of transformer from secondary bushings.

N. Secondary Terminations: air-filled compartment. Bushings shall be porcelain or cast resin epoxy side mounted on opposite side of transformer from primary bushings.

O. Other Accessories: secondary current transformers to IEEE C57.13.

P. Finish: Finish shall have a minimum dry film thickness of 3 mils. Color shall be ANSI 70, light grey.

Q. The main transformer tank and attached components shall be designed to withstand pressures 25% greater than the required operating design value without permanent deformation. Construction shall consist of carbon steel plate reinforced as required with sidewall braces. All seams and joints shall be continuously welded.

R. Each radiator assembly shall be individually welded and receive a quality control pressurized check for leaks. The entire tank assembly shall receive a similar leak test before tanking. A final six-hour leak test shall be performed after the transformer is tanked, welded and completed to ensure that there are no leaks before shipment.

S. Factory Tests and Reports: Provide certified test reports to the Contractor on each unit for the following:
1. Winding resistance.
2. Ratio, polarity, and phase relation.
3. No-load, full-load loss tests.
4. Exciting current, impedance, X/R ratio.
5. Applied and induced potential tests. All tests per IEEE C57.12.90.
6. Temperature test or tests shall be made on one unit only of a project covering one or more units of a given rating. Tests shall not be required when there is available a record of a temperature test on an essentially duplicate unit.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Verify field measurements as shown on the Drawings.
B. Verify that pads are ready to receive work.
C. Install in accordance with manufacturer's instructions.
D. Install safety labels to NEMA 260.

3.2 FIELD QUALITY CONTROL

A. Test distribution transformers in accordance with the manufactures requirements .

3.3 ADJUSTING
A. Adjust primary taps so that secondary voltage is within 2 1/2 percent above rated voltage at no load.

END OF SECTION

Technical Specification

Section 16171

Electric Motors

PART 1 -- GENERAL

3.1 WORK INCLUDED

A. This is a general specification and must be used in conjunction with the specification section for the equipment. Refer to the drawings for specific motor modifications.

B. This Section specifies all alternating current single-speed electric squirrel-cage induction motors in NEMA frame sizes 143 to 449, 250 hp and below, 300 and 350 hp in frame size 509, 460 volts and below, to be provided with the driven equipment specified under other equipment specifications.

3.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specification and related Contract Documents to establish the total requirements for electric motors.
1. Section 15050 - Basic Mechanical Requirements.

3.3 DESIGN CRITERIA

A. Motors shall be designed, built, and tested in accordance with the latest revision of the following standard documents.
1. NEMA MG 1 - Motors and Generators.
2. ANSI/IEEE 112 - Test Procedures for Polyphase Induction Motors and Generators.
3. UL 1004 - Motors, Electric.
4. UL 674 - Motors, Generators, Electric, for Use in Hazardous Locations: Class I, Groups C and D; Class II, Groups E, F, and G.

3.4 SUBMITTALS

A. Provide the following in addition to the standard requirements with the Bid:
1. Test results verifying guaranteed minimum efficiency and power factor at rated load and rated voltage for 3-phase motors larger than 1/2 hp. Report test results on Form A-1, IEEE Standard 112.
2. Motor outline, dimensions, and weight.
3. Manufacturer's descriptive information relative to specified features.
4. Motor Performance Characteristics:
a. Guaranteed minimum efficiency at rated load at rated voltage.
b. Guaranteed minimum power factor at rated load at rated voltage.
c. Expected efficiency at 1/2, 3/4, and full load at rated voltage.
d. Expected power factor at 1/2, 3/4, and full load at rated voltage.
e. Motor no-load current at rated voltage.
f. Full load current at rated voltage.
g. Full load current at 110 percent voltage.
h. Starting current at rated voltage.
i. Full load speed.
j. Certified copy of test report for identical motor tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B, showing full load efficiency and power factor not less than specified value. Motors not as specified will be rejected.
5. Vertical Motor Data:
a. Thrust bearing life.
b. Type of thrust bearing lubrication.
c. Type of guide bearing lubrication.

PART 2 -- PRODUCTS

3.1 ACCEPTABLE MANUFACTURERS

A. General Electric.

B. Magnetek.

C. U.S. Motors.

D. Reliance Electric.

E. Baldor

3.2 GENERAL

A. Provide motors of the type, horsepower, speed, mounting, enclosure type, construction, and specific modifications as specified on the drawings.

3.3 MOTORS 1/2 HP THROUGH 250 HP

A. General:
1. Type: All motors 1/2 hp through 250 hp shall be 3-phase, continuously rated, squirrel-cage, random-wound copper, induction motors designed for 460 volt, 60 Hz operation. Dual voltage (230/460) rated motors are acceptable if all leads are brought out to the motor junction box.
2. Insulation Class and Temperature Rise: Provide motors with Class F insulation and a Class B temperature rise based on 40 degrees C ambient. When ambient temperatures exceed 40 degrees C, temperature rise shall be adjusted according to MG 1-12.
3. Locked Rotor Current: Provide motors with locked rotor starting currents not exceeding Code L under 3 hp, Code K for 3 and 5 hp, Code H for 7-1/2 and 10 hp, and Code G for 15 hp and above.
4. Rating: Provide motors rated for continuous operation with 1.15 service factor. For constant speed motors, the driven load shall not exceed the motor's brake horsepower nameplate rating, exclusive of any service factor, under any normal operating condition.
5. Efficiency: Provide premium efficiency motors, when tested in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B.
6. Power Factor: Provide motors meeting power factor, based on tests in accordance with IEEE Standard 112.
7. Bearings:
   a. Provide horizontal motors with antifriction, grease lubricated ball bearings, with a bearing AFBMA L-20 life. Provide all bearings with grease addition and relief fittings.
   b. Recirculation air-handling units shall have sealed and permanently lubricated ball bearings.
8. Thrust Bearings: Provide vertical motors with grease lubricated thrust bearings with an AFBMA F-class life of 20 years. Provide all bearings with grease addition and relief fittings.
9. Conduit Box: Provide motors with conduit boxes that are fully rotatable, diagonally split, gasketed between cover and box, and box and frame, with threaded hubs and a grounding lug located within the box for ground conductor connection.
10. Nameplates:
   a. Provide nameplates of stainless steel or other approved corrosion resistant material to provide a permanent legible marking, containing NEMA data plus guaranteed minimum efficiency.
   b. Provide connection plate of stainless steel or other corrosion resistant material to provide a permanent legible marking for dual voltage motors. Locate the plate near the terminal box indicating the proper grouping of external leads for the power supply.
   c. Attach nameplates and connection plates to the motor frame by rivets or screws.

3.4 MOTOR TYPES

A. The following motor types, as specified on the drawings, shall conform to the following requirements in addition to the construction features specified in paragraph 2.3.
   1. Horizontal Dripproof: Provide horizontal motors with an enclosure that meets NEMA Standard MG 1 for open, dripproof construction. Provide screen over all air openings.
   2. Horizontal Totally Enclosed Fan-Cooled: Provide totally enclosed fan-cooled (TEFC) motors with frame sizes 182 and larger with cast iron frames and end shields. Smaller frame sizes may be constructed of rolled steel with cast metal end shields. Provide motors with condensate drain holes. For frame size 286 and larger, provide automatic breather/drain device in drain hole.
   3. Vertical Weather Protected Type I: Provide vertical motors with an enclosure that meets NEMA Standard MG 1 for weather protected Type I (WP-I) enclosure. Provide screens over all air openings.
   4. Vertical Totally Enclosed Fan-Cooled: Provide vertical motor with an enclosure identical to the requirements for the horizontal TEFC motors.
   5. Explosionproof: Provide all horizontal and vertical motors with TEFC explosionproof enclosures, UL listed for Class 1, Division 1, Group D hazardous atmosphere.
   6. Submersible: Submersible motors UL listed for explosionproof atmospheres in accordance with the above paragraph for explosionproof motors. In addition, provide submersible motors with two mechanical seals; the lower one outside the motor and protecting the upper one, which is in an oil filled chamber. Provide moisture detector probes in the oil filled seal chamber to indicate the presence of moisture in the seal chamber. Provide a temperature detector and switch rated 3 amps, 120 volts minimum, set to operate when the internal motor temperature exceeds a preset limit. Provide any relays or solid state controls for separate mounting.
   7. Horizontal, Totally Enclosed, Fan-Cooled, Severe Duty: Provide horizontal (TEFC), severe duty motors suitable for contaminated environments, including gasketed conduit box, stainless steel drains, double-shielded bearings, and corrosion resistant paint.
   8. Vertical, Totally Enclosed, Fan-Cooled, Severe Duty: Provide vertical (TEFC), severe duty motors with the requirements identical to horizontal (TEFC), severe duty motors, above.

3.5 MOTOR MODIFICATIONS

A. Any motor modifications specified in the detailed equipment specification shall conform to the following requirements in addition to the features previously specified.
   1. Space Heaters: Provide space heaters sized to prevent moisture condensation, rated 120 volts, with a separate conduit box for heater leads only.
   2. Embedded Thermal Detectors:
      a. Motors 15 hp and Below: Provide motors with a bimetal disk thermostat to sense winding overtemperature. Provide thermostat with automatic reset, normally closed contact rated 2 amps at 115 volts. Provide motor nameplate marked "OVER TEMP PROT 2" in accordance with NEMA MG 1-12.53.1.
      b. Motors Above 15 hp to 100 hp: Provide motors with temperature sensing device embedded in the motor winding that is sensitive to both overtemperature and rate of temperature rise. The sensor shall be wired to a NEMA 4 temperature monitor box located on the motor. The temperature sensing system shall be an automatic reset, normally closed contact, rated 2 amps at 115 Vac. The nameplate shall be marked "OVER TEMP PROT 1" in accordance with NEMA MG 1-12.53.
      c. Motors Above 100 hp: Provide a set of three thermistors, one thermistor embedded in the coils of each phase of the stator windings. Abnormally high temperature conditions in the stator windings shall result in a relay contact opening, for external use, that shall remain open until conditions return to normal (i.e., a lower temperature that is not damaging to the stator windings). Provide a relay in NEMA 4 enclosure, mounted on the motor, compatible with the thermistors, 120 Vac, and relay contact rated no less

than 5 amps, 120 Vac. Contact opening and return to normal closed conditions shall be automatic.

3.6 FACTORY TESTS

A. Provide factory test and test reports as listed below for all motors. For motors 100 hp and above, provide test reports for the actual motor being supplied. For motors under 100 hp, test reports of an identical motor may be provided. Perform all tests in accordance with the Procedures for Polyphase Induction Motors and Generators No. 112A and NEMA MG 1.
1. Measurements of no-load current and speed at normal voltage and frequency.
2. Measurement of locked rotor current at rated frequency.
3. Results of high-potential test.
4. Determination of efficiency and power factor at 1/2, 3/4, full-load, and service factor load.
5.

3.7 MOTORS DRIVEN BY ADJUSTABLE FREQUENCY DRIVES

A. Motors driven by adjustable frequency drives shall be inverter duty motors. Premium efficiency motors are not permitted to be driven by VFD's.

B. Provide bearing insulator, glastic fiberglass-reinforced thermoset polyester Grade 1412-A.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendations.

B. Base Mounted Motors

1. Where the motor is mounted on a steel base, the motor shall be mounted on a common, fabricated steel base plate.

2. Where the motor is mounted on a concrete base, the motor shall be mounted on a raised concrete pad as per the drawings. The base shall be of the type that is fastened by bolts and shall have provision for adjustment and alignment of the pump and/or fan [other load] and motor. The concrete base shall be perfectly level. It shall be the Contractor's responsibility to assure that the base is finished level and that hold-down bolts are provided in their proper location.

3. Where the motor is mounted on a concrete base with a steel base plate, the steel base plate shall be a common, fabricated steel, fully enclosed base plate having a sufficient grout volume with adequately sized grout holes.

C. For 3-phase motors connecting to wire sizes #12 to #4/0, use Thomas & Betts MD series quick connect/disconnect motor pigtail connectors with insulating boot.

3.2 FIELD TESTS

A. Perform the following tests on all motors, and submit "installed motor test" results prior to putting motors into service and acceptance by the Contractor. Provide all test equipment with certified calibration label to perform the tests.
1. Measurement of no-load and full-load current (each phase).
2. Megger test (500-volt megger).
3. Inspection of bearings and lubrication.
4. Rotational check.
5. Coupling check.
6. All other tests specified in the equipment manufacturer's O&M Manual for field tests prior to startup.

END OF SECTION

INDUCTION ELECTRIC MOTOR

Motor tag number	DI01/DI02
Motor type	Squirel Cage Induction
Horsepower rating	60
Motor starter	VFD
Synchronous speed (rpm)	3600
Speed (rpm)	3510
Mounting 364TSC	
Enclosure type	TEFC
Volts, phase, frequency	480/3/60
Full load current (amps)	72
Construction	NEMA Design B
Modifications	None
Efficiency	
Full load	94%
3/4 load	94%
1/2 load	93%
Power factor	
Full load	92%
3/4 load	_____
1/2 load	_____
NEMA frame size	_____
Manufacturer's designation	_____
Net weight (pounds)	_____

Technical Specification

Section 16321

Distribution Transformers
Dry & Oil

PART 1 – GENERAL

3.1 WORK INCLUDED

A. Dry-type, secondary distribution transformers, 500KVA or larger with 12470V primary.

B. Provide cast coil transformers complete from the incoming line section to secondary connections with all fans, terminal blocks, insulators, thermostats, enclosure, and nameplates to form complete transformers.

C. Liquid-filled secondary distribution transformers, 500KVA or larger with 12470V primary.

3.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for distribution transformers:
1. Section 16010 - Basic Electrical Requirements.
2. Section 16361 - Air Interrupter Switchgear.

3.3 SUBMITTALS

A. Provide the following within 2 weeks of award of Subcontract:
1. Transformer diagrammatic nameplate for each unit.
2. Data indicating standard model design tests.
3. Thermal and mechanical transformer damage characteristic curves.

PART 2 – PRODUCTS

3.1 VENTILATED DRY-TYPE CAST COIL SECONDARY DISTRIBUTION TRANSFORMERS

A. Acceptable Manufacturers:
1. General Electric Company.
2. Westinghouse.

B. Dry-Type, Ventilated Cast Coil Secondary Distribution Transformers: ANSI C57.12, three-phase, self-cooled/forced air-cooled transformer. Frequency 60 Hz.

C. The transformer unit shall have no clearance or combustible area restrictions that would require the addition of a fire extinguishing system.

D. Primary Voltage: As indicated on the Drawings. Provide four 2 1/2 percent full capacity taps, two above primary rated voltage, and two below primary rated voltage taps. Taps shall be accessible through removable panels on transformer. Primary-voltage taps shall have leads terminated at the coils and equipped with provisions to change taps. For a given winding, the number 1 or letter A shall be assigned to the tap providing the maximum ratio of transformation.

E. Impedance: as shown on the Drawings.

F. Basic Impulse Levels:
   1. Primary Voltage: 95 kV at 15 kV.
   2. Secondary Voltage: 30 kv at 480V;.

G. Transformers shall be Class AA/FA. Units shall have cooling fans capable of allowing transformer to operate with a 25 percent increase of capacity without exceeding temperature limits of the insulation system. Units shall be capable of delivering rated kVA continuously, either self-cooled, or fan-cooled, when operating in a rated ambient, without accelerated loss of life.

H. Cooling Fans:
   1. Fan cooling equipment shall be controlled automatically by a sensor attached to the center-phase low-voltage winding. Forced-air cooling system shall include fans, control wiring, and controller with test switch.
   2. Fans shall be powered from source external to transformer.
   3. Fusing shall be adequate to protect fans.

I. Maximum Sound Level (self-cooled/fan-cooled):
   1. 1000kVA or smaller: 65/69 dB.
   2. 1000kVA or larger: 68/71 dB.

J. Units shall have digital thermometer, connected to the B phase, to indicate winding temperature in degrees C, with maximum reading recall capability and contacts to control fans, plus 5A, 120V Form C contacts for remote alarm and trip. All power and control connections for fans shall terminate in a NEMA 3R terminal box.

K. Accessories: ANSI C57.12; standard accessories.

L. Core:
   1. The transformer core shall be constructed of high-grade, grain-oriented silicone steel laminations, with high magnetic permeability. Magnetic flux density is to be kept well below the saturation point. The core shall be cruciform in shape, with metered joints to keep core losses, exciting current, and noise level at a minimum. The outside surfaces of the core shall be protected from corrosion by painting with a suitable coating after assembly. The top yoke of the core shall not be painted.
   2. The core shall be grounded to the frame by means of a flexible grounding strap.
   3. As a noise-reducing measure, vibration-isolating pads shall be placed between the core and coil assembly and the transformer base.

M. Windings:
   1. Both primary and secondary voltage windings and all external buswork shall be copper. High-voltage windings shall be separately cast as rigid coils utilizing strip-disk winding construction. Low-voltage windings shall utilize full-height sheet conductor material and shall be fully encapsulated. Coils shall be supported by cast epoxy bottom supports and space blocks and resilient top blocks, in order to absorb thermal expansion and contraction of coils. There shall be no rigid mechanical connection between HV and LV coils.

2. Transformer properties shall be as follows:
   a. Thermal: Thermal strength to withstand fluctuating operating temperatures to 130 degrees C and down to minus 40 degrees C without damage to the insulation.
   b. Physical: Short circuit capability that meets the requirements of ANSI Standard C57.12.90.
3. The transformer shall be designed to carry short-time emergency overloads in accordance with ANSI C57.92 and NEMA TR98 as applicable. Duration and magnitude of designed withstand capability shall be as outlined in ANSI C57.12 and the latest draft of the IEEE short circuit test code.
4. The windings must not absorb moisture and shall be suitable for both storage and operation in adverse environments, including prolonged storage in 100 percent humidity at temperatures from minus 40 degrees C to plus 40 degrees C and shall be capable of immediately being switched on after such storage without predrying.

N. Primary Terminations: Air-filled compartment or air-interrupter switch. Reference Section 16361, Air Interrupter Switchgear. Terminals shall be copper, 4-hole-bolted type, side-mounted on opposite side of transformer from secondary (low voltage) terminals. Terminals shall be mounted directly on the ends of the transformer high-voltage bus. The terminals shall be identified by H1, H2, H3 for reference to A, B, C phases, respectively, and so indicated on the nameplate. The air-filled chamber shall be full-height sheet steel structure with bolted, removable front and side panels, open bottom, and sufficiently sized for bottom feeder entrance. Connections between the primary switches and transformer shall be [flexible bus braid or cable] [buss connections]. The connection shall be arranged so that upon disconnecting and removing the primary connection, the transformer may be lifted vertically (by a customer-furnished overhead crane) without disturbing or disassembling the primary switch structure.

O. Transformers will be utilized in a low-resistance neutral grounded system and shall be fully insulated. The "X_0" or neutral bus shall not be grounded either internally or externally, and shall be accessible for connection to a neutral grounding resistor (provided by others) to be located remote from the transformer.

P. Secondary Terminations: copper, throat-coupled to secondary section. Electrical characteristics of completely assembled low-voltage terminations shall comply with ANSI C57.12.01-1989 (or later edition) unless otherwise stated. Terminals shall be side-mounted on opposite side of transformer from primary (high voltage) terminals. Connections to secondary switchgear shall be by means of copper bus bar having flexible sections of laminated copper strip. The air-filled terminal chamber shall be made of sheet steel with bolted, removable panels.

Q. A ground cable lug shall be provided inside the termination chambers for connecting the equipment grounding conductors and shields furnished with the phase conductors.

R. Construction:
   1. The transformer enclosure shall be of sheet steel panels bolted together, suitable for outdoor installation, when indicated, and complete with the following fittings:
      a. All ventilating openings shall be in accordance with NEMA and National Electrical Code standards for ventilated enclosures.

b. Undercarriage shall be of steel plate, rigidly constructed, and fitted with flangeless rollers and jacking pads.
c. Lifting lugs to lift the complete transformer.
d. Rating and connecting diagram plate.
e. Grounding provisions shall consist of two ground pads welded on the base or on core frames near the base. One additional ground pad shall be furnished near each neutral bushing.
f. High-Voltage Taps: Tap leads shall be terminated at the coils and equipped with provisions for changing taps.
g. Provide side, front, and rear covers with removable captive screw-on plates having formed edges on all sides. Captive screws or bolts shall not be able to be easily knocked out of their retainers.

S. Finish: Finish shall have a minimum dry film thickness of 3 mils. Color shall be ANSI 61, light grey.

T. Factory Tests and Reports: Provide certified test reports on each unit.
1. Purchaser shall have the right to witness all tests and shall be notified at least 5 working days in advance of any tests to allow his representative to be present.
2. Purchaser may assign an inspector to inspect the equipment, as well as to expedite the fabrication and manufacturing of the transformer.
3. Tests: The following tests shall be made on the transformer and all tests shall be made in accordance with the latest revision of ANSI Test Code C57.12.90.
a. Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only.
b. Ratio tests on the rated voltage connection and on all tap connections.
c. Polarity and phase-relation tests on the rated voltage connections.
d. No-load loss at rated voltage on the rated voltage connection.
e. Exciting current at rated voltage on the rated voltage connection.
f. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only.
g. X/R ratio.
h. Applied potential tests.
i. Induced potential tests.
j. Regulation at 100 percent and 80 percent power factor.
k. Temperature test or tests shall be made on one unit only of a project covering one or more units of a given rating. Tests shall not be required when there is available a record of a temperature test on an essentially duplicate unit.

U. Nameplates: A stainless steel nameplate shall be mounted approximately at eye level height on the transformer enclosure and shall present, as a minimum, the following information:
1. Graphic representation of the connections of the high-voltage and low-voltage windings.
2. The KVA ratings at all cooling class ratings and temperature rises.
3. Transformer impedance at rated temperature.
4. Tap changer positions, voltages, and full-load currents at each tap setting.
5. Low-voltage rating and full-load current.

6. Total weight, weight of core and coils, and weight of tank and fittings.
7. Conductor material of each winding.

V. Identification Nameplates: Laminated plastic with engraved letters on each unit. Refer to detailed design drawings

3.2 LIQUID-FILLED SECONDARY DISTRIBUTION TRANSFORMERS

A. Acceptable Manufacturer:
1. General Electric Company.
2. Westinghouse.

B. Liquid-filled Secondary Distribution Transformers: ANSI C57.12.00; 3-phase, self-cooled transformer; frequency, 60 Hz.

C. Capacity: as shown on the Drawings.

D. Primary Voltage: 12.47 kV, delta connected. Provide two each 2-1/2 percent full capacity above normal and full capacity below normal primary taps, with externally-operated tap changer.

E. Secondary Voltage: as shown on the Drawings.

F. Impedance: as shown on the Drawings.

G. Basic Impulse Level: 95 kV.

H. Cooling and Temperature Rise: ANSI C57.12.00; Class OA/FA. The transformer shall carry its continuous rating with average winding or temperature rise by resistance that shall not exceed 65°C rise, based on an average ambient of 40°C over 24 hours with a maximum of 50°C.

I. Units with fans or provisions for future fans shall be equipped with dial-type thermometer with contacts to control fans. All power and control connections for fans shall terminate in a NEMA 4 terminal junction box. Fan power and control shall be 120 volts, single phase with source of power provided by others.

J. Liquid: The unit shall be mineral oil filled and shall be in accordance with the latest edition of the NEC. [Oil shall have inhibitor (at factory) per ASTM D2668.] Oil shall be PCB-free. Transformer shall be shipped oil filled with a 2 psig nitrogen charge.

K. Accessories: ANSI C57.12.00 standard accessories and magnetic dial-type liquid level gauge, dial-type thermometer with alarm contact, stainless steel diagrammatic nameplate on side of unit, 1-inch upper filter press and filling plug, 1-inch drain valve with sampling device, vacuum-pressure gauge and pressure relief valve.

L. Windings: copper.

M. Primary Terminations: air-filled compartment. Bushings shall be porcelain or cast resin epoxy side mounted on opposite side of transformer from secondary bushings.

N. Secondary Terminations: air-filled compartment. Bushings shall be porcelain or cast resin epoxy side mounted on opposite side of transformer from primary bushings.

O. Other Accessories: secondary current transformers to IEEE C57.13.

P. Finish: Finish shall have a minimum dry film thickness of 3 mils. Color shall be ANSI 70, light grey.

Q. The main transformer tank and attached components shall be designed to withstand pressures 25% greater than the required operating design value without permanent deformation. Construction shall consist of carbon steel plate reinforced as required with sidewall braces. All seams and joints shall be continuously welded.

R. Each radiator assembly shall be individually welded and receive a quality control pressurized check for leaks. The entire tank assembly shall receive a similar leak test before tanking. A final six-hour leak test shall be performed after the transformer is tanked, welded and completed to ensure that there are no leaks before shipment.

S. Factory Tests and Reports: Provide certified test reports to the Contractor on each unit for the following:
1. Winding resistance.
2. Ratio, polarity, and phase relation.
3. No-load, full-load loss tests.
4. Exciting current, impedance, X/R ratio.
5. Applied and induced potential tests. All tests per IEEE C57.12.90.
6. Temperature test or tests shall be made on one unit only of a project covering one or more units of a given rating. Tests shall not be required when there is available a record of a temperature test on an essentially duplicate unit.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Verify field measurements as shown on the Drawings.
B. Verify that pads are ready to receive work.
C. Install in accordance with manufacturer's instructions.
D. Install safety labels to NEMA 260.

3.2 FIELD QUALITY CONTROL

A. Test distribution transformers in accordance with the manufactures requirements .

3.3 ADJUSTING
A. Adjust primary taps so that secondary voltage is within 2 1/2 percent above rated voltage at no load.

END OF SECTION

Technical Specification

Section 16361

Air Interrupter Switch
Medium Voltage

GENERAL

4.1 Furnish 15 KV sectionalizing switches as described herein.

4.2 The switches shall be S & C Electric Company Mark III pad-mounted manual switches, type PMH-10.

REQUIREMENTS/STANDARDS FOR DRAWINGS AND DATA

4.1 Text

A. The text on all drawings/data shall be the English language. Text in the language of the Vendor may also be shown, provided the English translation is shown in the prominent location.

4.2 Conformance

A. All drawings and data, including Vendor's standard drawings shall be checked for accuracy, clarity, completeness and conformance with the applicable codes, specifications etc. before submitting to Intel.

Pad-Mounted Individual Switches

4.1 The pad-mounted gear shall be in accordance with 12 KV distribution system one-line diagram and shall conform to the following specification.

4.2 The pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and the necessary accessory components, all completely factory-assembled and operationally checked.

4.3 Ratings:

A. The electrical ratings for the integrated pad-mounted gear shall be as designated below:

KV, System---------- 12.47KV, 3 Phase, 60 Hz
KV, Nominal---------- 14.4KV
KV, Maximum Design---------- 17.0KV
KV, BIL---------- 95KV
Main Bus Continuous, Amperes---------- 1200A
Three-Pole Interrupter Switches
Continuous, Amperes---------- 600A
Load Dropping, Amperes---------- 600A
Two-Time Duty-Cycle Fault Closing,
Amperes Rms Asymmetrical---------- 22,400A
Short-Circuit Ratings
Amperes, Rms Symmetrical---------- 20,000A
Mva Three-Phase Symmetrical at
Rated Nominal Voltage---------- 350MVA

B. The momentary and two-time, duty cycle, fault-closing ratings of switches, momentary rating of bus shall equal or exceed the short circuit ratings of the pad-mounted gear.

C. The design and construction of the pad-mounted gear assembly shall conform to the latest edition of ANSI/IEEE Standard C37.20.3.

D. The pad-mounted gear assembly shall be suitable for outdoor installation under following conditions.

- Maximum ambient temperature 44°C
- Minimum ambient temperature 0°C
- Maximum humidity 80% RH
- Special conditions Fine Dust

4.4 Certification of Ratings:

A. The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and components as well as the complete integrated pad-mounted gear assembly as rated.

B. The manufacturer shall furnish certification of ratings of the basic switch and/or the integrated pad-mounted gear assembly consisting of the switch in combination with the enclosure.

C. The pad-mounted gear shall conform to or exceed the applicable requirements of the following standards and codes:

- Applicable safety and health standards promulgated pursuant to Federal Occupational Safety and Health Act of 1970 which are in effect 30 days prior to the date of quotation or bid.
- Article 710-21(e) in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
- All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

4.5 To ensure a completely coordinated design, the pad-mounted gear assembly shall be constructed in accordance with the minimum construction specifications of the switch manufacturer to provide adequate electrical clearances.

4.6 In establishing the requirements of the enclosure design, consideration shall be given to all relevant factors such as controlled access and tamper resistance.

A. The ground-connection pad shall be constructed of 3/8 inch thick steel, which shall be nickel-plated and welded to the enclosure, and shall have a short-circuit rating equal to that of the integrated assembly.

B. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

4.7 Construction - Enclosure Including Outdoor Finish:

A. Enclosure:

B. The pad-mounted gear enclosure shall be of unitized monocoque (not structural frame and bolted sheet) construction to maximize strength, minimize weight, and inhibit corrosion.

C. The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.

D. All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth.

E. The gas-shielded short-circuiting transfer welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.

F. Any welds made by other than this method shall be ground and sanded (wire brushed if internal) to remove all scale and alkaline residues formed during welding.

G. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

H. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

I. The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

J. Enclosure top side edges shall overlap with roof side edges to create a mechanical maze which shall allow free-flow ventilation to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.

K. A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.

L. Insulating interphase and end barriers of NEMA GP03 grade, fiber-glass-reinforced polyester shall be provided for each interrupter switch where required to achieve BIL ratings. Additional insulating barriers of the same material shall separate the front compartments from the rear compartments and isolate the tie bus.

M. Full length steel barriers shall be provided to seperate adjoining compartments with source switches rated 600 amperes continuous.

N. Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent

corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be closed-cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

O. Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gap when the switch is open. A window panel shall be provided to allow viewing of the switch position without removing the barriers.

P. A steel-compartmented base spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting pad by 6 inches.

4.8 Basic Components

A. Interrupter Switches

1. Interrupter switches shall have a two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the integrated pad-mounted gear assembly. These ratings define the ability to close the interrupter switch twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed on representative test specimens at maximum design voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished.

2. Interrupter switches shall utilize a quick-make, quick-break mechanism installed by the switch manufacturer. The mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch-operating hub speed.

3. Interrupter switches shall be operated by means of an externally accessible 3/4 inch hex switch-operating hub. The switch-operating hub shall be located within a recessed pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4 inch deep socket wrench or a 3/4 inch shallow-socket wrench with extension. The switch-operating hub pocket shall include a pad lockable access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch-operating hub to prevent overtravel and thereby guard against damage to the interrupter switch mechanism. Labels to indicate switch position shall be provided in the switch-operating hub pocket.

4. Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path with steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

B. Where indicated on the drawings, install Fault Filer Fault Detector #1515WB-39192 on switchgear.

Primary Side Switch for 12470V Transformers

4.1 The primary fused switch shall be of the duplex type with current limiting fuses and consist of deadfront, completely metal-enclosed free-standing structures containing interrupter switches and fuses of the number, rating and type noted on the drawings or specified herein. All switches shall meet or exceed all applicable NEMA, ANSI and IEEE Standards.

4.2 The primary switches shall be bus connected to the transformer primary terminals. Flexible bus braid shall be provided to make the final connections. The connection shall be arranged so that upon disconnecting and removing the flexible bus braid, the transformer may be lifted vertically (by a customer-furnished overhead crane) without disturbing or disassembling the primary switch structure.

4.3 The load interrupter switches shall be quick-make, quick-break three pole, gang operated, with stored energy operation. Each switch shall have the following minimum ratings:

- System Voltage 12.47 kV three phase three wire
- Maximum Design Voltage 15 kV
- Basic Impulse Level 95 kV

- Amperes Continuous 600 Amperes
- Amperes Interrupting 600 Amperes
- Momentary Switch Closed, 10 cycle 80 kA Amps. Asym.
- Fault Close 61 ka Amps. Asym.

4.4 A manual over toggle type mechanism shall be supplied which utilizes a heavy duty coil spring to provide opening and closing action of the switch. The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to tease the switch into any intermediate position.

4.5 The interrupter switch shall have separate main and make/break contacts to provide maximum endurance for fault close and load interrupting duty. The switch assembly shall have insulating barriers between phases and between outer phases and the enclosure.

4.6 The switch assembly shall be integrally designed and produced by the manufacturer of the interrupter switches, fuses and enclosures to assure a completely coordinated design and establish one source of responsibility for the equipment's performance.

Construction

4.7 The following features shall be supplied on every three pole, two position open-closed switch:

A. A high impact viewing window that permits full view of the position of all three switch blades through the closed door.

B. A fuse access door interlocked with the switch so that:

1. The switch must be opened before access to the fuses is possible.

2. The door must be closed before the switch can be closed.

C. A grounded metal barrier in front of every switch to prevent inadvertent contact with any live part, yet allow for a full-view inspection on the switch blade position.

D. Provision for padlocking the switch in the open or closed position.

E. Permanent "Open-Closed" switch position indicators.

4.8 Fault protection shall be furnished by fuses. Fuses shall have a minimum interrupting rating of 65,000 Amperes Symmetrical at 12.47kV.

4.9 One two hole NEMA pad per phase shall be provided for attaching contractor supplied Compression/crimp type cable terminals suitable for 2-500MCM copper cables per phase. Sufficient vertical space shall be supplied for contractor supplied electrical stress relief termination system.

4.1 All bus shall be tin plated copper and be mounted on NEMA rated glass polyester insulators. All bussing shall be braced for the maximum available fault current.

4.2 Enclosure construction shall be of the universal frame type using dieformed, welded and bolted members. All enclosing covers and doors shall be fabricated from not less than 11-gauge steel. To facilitate installation and maintenance of cables and bus, rear hinged padlockable doors shall be supplied.

4.3 Each switch cubicle shall have a single, full length, flanged front door over the switch and fuse assembly and shall be equipped with two rotary latch type padlockable handles. Provision shall be made for operating the switch and storing the removable handle without opening the full length door.

4.4 Outdoor units shall have a sloped drip-proof roof. All openings shall be screened to prevent the entrance of small animals, and barriered to inhibit the entrance of snow, sand, etc. A minimum of one 250 watt, 120 volt space heater shall be provided in each cubicle. Power for the space heater shall be provided by the customer.

4.5 All enclosing and supporting steel shall be painted with manufacturers standard finish coat. Color shall be ANSI 61.

4.6 Small wiring, fuse blocks and terminal blocks within the switch shall be furnished as indicated on the drawings. All groups of control wires shall be labeled with wire markers and all wires leaving the switch shall be provided with terminal blocks having suitable numbering strips.

4.7 A nameplate shall be mounted on the front door of the switch cubicle.

4.8 Supply Kirk key interlocks to prevent closing both primary switches simultaneously.

4.9 9kV station class surge arresters, Type SMX, shall be provided connected at the incoming terminations and securely grounded to the metal structure.

5.1 Labeling

A. Warning Signs

1. All external doors shall be provided with "Caution - High Voltage - Keep Out" signs. Also, permanent warning sign, "Warning - Deenergize All Power Sources Before Service."

2. The inside of each door shall be provided with a "Danger - High Voltage - Keep Out - Qualified Persons Only" sign. Also, provide warning sign, "Switches May Be Energized in Any Position."

3. The inside of each door providing access to an interrupter switch shall be provided with a warning sign indicating that "Switch Blades May Be Energized in Any Position."

4. The inside of each door providing access to power fuses shall be provided with a warning sign indicating that "Fuses May Be Energized In Any Position."

B. Nameplates, Ratings Labels and Connection Diagrams:

1. The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturer's name, catalog number, and model number.

2. The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes, rms symmetrical and Mva three-phase symmetric at rated nominal voltage); and interrupter switch ratings, including duty-cycle fault-closing capability and amperes, short-time, rms (momentary, asymmetrical and one-second, symmetrical).

3. A three-line connection diagram showing interrupter switches and bus along with the manufacturer's model number shall be provided on the inside of the front and rear doors (or set of double doors), and on the inside of each switch-operating hub access cover.

4. Provide permanent etched plastic single-line diagram to show the following:
   a) PMH-10 one line arrangement.
   b) Direction and/or source of each 12.47 kV feeder terminating or originating at the sectionalizing switch.
   c) Diagram to be mounted on outside of switch unit.

5. Interrupter switch contacts shall be of silver-to- silver construction for current transfer, and shall be backed up by stainless steel springs to provide constant high contact pressure.

6. Interrupter switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.

7. Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.

8. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of correct switch position.

9. Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating hub pocket by a brass chain. The folded handle shall be stored behind the closed switch-operating hub access door.

10. Key interlocks shall be provided to guard against opening fuse compartment door(s) unless all switches are locked open.

11. Shaft locks shall be provided to mechanically secure switches against movement from either the open or closed position.

12. Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment and on terminals and ground pads in any bus compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

13. Interrupter switch terminals and bus compartment terminals shall be provided with adapters to accommodate four cables per phase.

14. Cable guides shall be provided to help orient cables at switch and bus compartment terminals.

5.2 Doors

A. Doors shall be constructed of 11 gauge hot-rolled, pickled and oiled steel sheet.

B. Door-edge flanges shall overlap with door-openings flanges and shall be formed to create a mechanical maze that shall guard against dust and water entry and discourage

tampering or insertion or foreign objects, but shall allow free-flow ventilation to help keep the enclosure interior dry.

C. Doors shall have a minimum of three stainless-steel hinges and hinge pins. The hinge pins shall be welded in place to guard against tampering.

D. In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with a three-point latching mechanism.

E. The latching mechanism shall be spring loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

F. A pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

G. The latching mechanism shall have provision for padlocking that incorporates a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

H. It shall not be possible to unlatch the mechanism until the padlock is removed.

I. It shall not be possible to insert the padlock until the mechanism is completely latched closed.

J. Each door shall be provided with a galvanized steel door holder located above the door opening. These holders shall be hidden from view when the door is closed, and it shall not be possible for the holders to swing inside the enclosure.

5.3 Finish:

A. Any welds made by other than the gas-shielded short-circuiting transfer welding process shall be ground and sanded (wire brushed if internal) to remove all scale and alkaline residues formed during welding.

B. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

C. All exterior seams shall be filled and sanded smooth for neat appearance.

D. To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process before any protective coatings are applied.

E. After the finishing system has been properly applied and cured, welds along the enclosure bottom flange and around the door hinges shall be coated with a waxed-based anticorrosion moisture barrier to give these areas added corrosion resistance.

F. A resilient closed-cell material, such as PVC gasket, shall be applied to the entire underside of the enclosure bottom flange to protect the finish on this surface from scratching during handling and installation. This material shall isolate the bottom flange from the alkalinity of a concrete foundation to help protect against corrosive attack.

G. After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finishes shall be inspected for scuffs and scratches. Blemishes shall be carefully touched up by hand to restore the protection of the finish.

H. The finish shall be light gray, No. 70, ANSI Standard Z55.1.

I. To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motor shall be of either nonferrous materials, or galvanized or zinc-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

J. In consideration of tamper resistance, the enclosure shall conform to or exceed the requirements of NEMA TR1-2.01, except that the test values shall be increased to the following levels:

- Inward Axial Force - 50 pounds
- Prying Leverage Tests - 75 foot - pounds
- Pull Test - 150 pounds

INSTALLATION

6.1 Arrange for delivery to the site and off-loading at Owner's designated location.

6.2 Record drawings shall be furnished providing the following information: complete rating, short circuit withstandability of bus and of lowest rated device, overall outline dimensions including space available for conduits, circuit schedule showing circuit number, device description, device frame rating, trip or fuse clip ampere rating, feeder circuit identification, conductor sizes and one-line diagram with each circuit device numbered.

6.3 Label all compartments per Section 16195.

END OF SECTION

Technical Specification

Section 16430

Low voltage
Metal Clad Switchgear

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Furnish and install low-voltage, metal-clad switchgear, complete, rated 480 volts; for service and voltage as indicated on the Drawings.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced switchgear:
   1. Section 16010 - Basic Electrical Requirements.

1.3 SUBMITTALS

A. Provide the following in addition to the standard requirements with the Bid:
   1. Size and number of bus bars per phase and ground.
   2. Instrument meter and instrument transformer descriptive literature.
   3. Electrical characteristics including voltage, frame size, trip ratings, and integrated equipment short-circuit ratings.
   4. Manufacturer's original transparencies of time current curves for each type and size of overcurrent protective device.
   5. One-line diagram superimposed on a front elevation showing instrumentation bus and protective device location.

PART 2 – PRODUCTS

3.1 LOW-VOLTAGE METAL-CLAD SWITCHGEAR

A. Acceptable Manufacturer:
   1. General Electric Company.
   2. Westinghouse

B. Switchgear Construction and Ratings:
   1. Factory-assembled, dead-front, metal-enclosed, self-supporting NEMA 1 drawout switchgear assembly. Similar to type "DS" and "DSL" Drawout Power Switchgear. All major components shall be of the same manufacture as the switchgear. The entire assembly shall be suitable for 600 volts maximum AC Service.
   2. Multiple vertical sections, each containing provisions to accept air break power circuit breakers.
   3. Provide ventilators located on the roof of the switchgear with a maximum height of four inches. Ventilators shall have front and rear grills with solid top and shall extend from left to right over the breaker and bus compartment to provide adequate ventilation.
   4. Switchgear shall comply with the latest applicable standards of ANSI C37.13, C37.16, C37.17, and C37.20; NEMA SG3 and SG5, and shall be UL labeled.

Certified copies of design test reports shall be supplied, demonstrating compliance with these standards when requested by the engineer.

5. Switchgear shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.
6. Each ventilated breaker compartment shall be completely separated from other breaker compartments and bus work by grounded metal barriers.
7. [Hinged rear doors which can be bolted and padlocked closed shall be provided for each vertical section.] [The sides and rear shall be covered with removable screw-on plates.] All edges of front covers or hinged front panels shall be formed.
8. Each breaker shall be equipped with drawout rails, levering out mechanism, primary and secondary contacts. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells.
9. Each breaker shall have a mechanism capable of moving the breaker to one of four positions:
   a. Connected (primary and secondary contacts engaged).
   b. Test (primary contacts disengaged, secondary contacts engaged).
   c. Disconnected (primary and secondary contacts disengaged).
   d. Removed.
10. Each breaker compartment shall be fitted with shutters which cover the primary line (bus) and load connections when the breaker is in the disconnected or removed position.
11. Areas for conduit and/or busduct entry shall be provided in each vertical section as indicated on the Drawings.
12. Brackets to accommodate training and securing of cables shall be provided. Full vertical insulated barriers shall separate adjacent vertical sections.
13. Each breaker compartment shall have a hinged door. The breaker shall be capable of operating with the door open or closed. The breaker shall be capable of being moved into the connected, test, or disconnected positions with the door closed. Trip settings to be accessible with breaker open or closed.
14. Wiring: Provide switchboard-type wiring with all wiring individually identified at each end. Terminate on terminal blocks all control and instrumentation circuits requiring external connection or crossing shipping splits. Provide 600-volt, 20-amp terminal blocks, Marathon 601RZ. Provide ring-type compression terminals (connectors), by Amp, for all control and instrumentation terminations. Provide each terminal block with a marking strip, factory marked in black, indelible ink with terminal numbers corresponding to numbering on shop drawings. Use SIS-type wire for all control and instrument circuits, making all terminations with ring-type compression terminals, Thomas & Betts "Sta-kon" or equal. Size the wire to suit load requirements with No. 14 AWG minimum size. Provide 25 percent spare terminal points. Terminate all current transformer leads on shorting-type terminal blocks.
15. Line Terminations: rear accessible.
16. Key Interlocks: Provide mechanical key interlocks where indicated on the Drawings. Interlocking scheme shall be as indicated. Provide 2 sets of spare keys.

C. Bus Work:
   1. Main Bus: Provide phase isolated and insulated copper bus work of sufficient cross section to limit temperature rise at rated current to 55 degrees C; provide bus with

full tin plating, except at sliding connections, which shall be silver-plated; provide bus arrangement of Phase A-B-C, left to right, top to bottom, and front to rear, as viewed from the front; provide main horizontal bus with a continuous current rating as shown; braced for stresses from short-circuit currents as shown. Provide a full capacity horizontal bus in all sections (not tapered) with provision for future extension at each end; provide complete buswork for all branch devices shown as future; provide full capacity neutral; provide buses mounted on heavy-duty glass polyester supports.

2. Ground Bus: Provide a copper ground bus 1/4-inch by 3-inch minimum cross section extending the entire length of the switchgear, bolted to each vertical section, with a ground lug for one No. 4/0 bare copper conductor on each end of the bus.
3. All bus work shall be rated to withstand maximum short-circuit stresses when connected to a supply system having a fault capacity as shown on the drawings.

D. Mimic Bus: Show bussing, connections, and devices in single-line form on the front panels of the switchgear using blue laminated plastic strips fastened flat against the panel face with stainless steel screws or rivets.

E. Overcurrent Protective Devices:
1. Power Circuit Breakers: Provide with digital, true rms, and positive flux-transfer trip device. Mains, tie and feeder breakers shall be drawout mounted. Breakers shall be manually operated stored energy mechanism, 100 percent rated. Operating handle shall be capable of being padlocked in the OFF position. Devices shall have separate push-to-close and push-to-open push buttons. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering "In" or "out" of the cell.
2. Main, Tie and Feeder protective devices shall be draw-out power circuit breakers, Westinghouse type "DS" or "DSL" or approved equal. Frame ratings shall be as shown on the drawings.
3. Feeder Power Circuit Breakers shall include current limiting fuses, if required, integrally mounted on 800 ampere and 1600 ampere frames. Current limiters shall be coordinated with the breaker trip device, so as to avoid unnecessary blowing of the current limiters. Breakers shall include an anti-single phase device that will trip the breaker in the event of a blown limiter, indicate from the front of the breaker which limiter is blown, and prevent the breaker from being re-closed on a single phase condition, due to missing or blown limiters.
4. Breakers shall have the following trip functions (unless stated otherwise on drawings):
   a. Current Setting: adjustable.
   b. Long-Time Pickup: adjustable.
   c. Long-Time Delay: adjustable.
   d. Long-Time Timing Light.
   e. Short-Time Pickup: adjustable.
   f. Short-Time Delay: adjustable.
   g. Short-time I^2t switch.
   h. Instantaneous Pickup:
      1) Mains and Ties: none.
      2) Feeders: adjustable.
   i. Ground Fault Pickup: adjustable.

j. Ground Fault Delay: adjustable.
k. Trip Indication Targets: overload, short circuit, and ground fault.
l. Zone selective interlock for ground fault and short time.
m. Ground fault system shall be residual type. Where switchgear is part of a double-ended system, the ground fault system shall be suitable for an installation where each transformer is connected directly to the grounding electrode conductor. "T" scheme (single point) grounding of transformers is not approved.

5. Each breaker shall have a visible indicator to indicate breaker position and state.
6. Each breaker shall be provided with two normally open and two normally closed auxiliary contacts.
7. Supply one complete set of specialized tools necessary for operation and maintenance for each lineup of switchgear.
8. Power circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes rms at rated voltage. Power circuit breakers with current limiting fuses shall have a 200,000 ampere rms symmetrical interrupting capacity at 600 volts and below. Current limiters shall have maximum peak let through currents equal to or less than the latest published values by the manufacturer.

F. Trip Unit

1. Provide trip units for all circuit breakers. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.

2. The trip unit shall have an information system that provides LED's to indicate mode of trip following an automatic trip operation.

3. The trip unit shall be provided with a display panel that indicates the protection function settings. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.

4. Complete system selective coordination shall be provided by the addition of the following individually adjustable time/current curve shaping solid state elements unless stated otherwise on the drawings:

   a. Breakers shall have adjustments for long delay pick-up and time.

   b. Breakers shall have individual adjustments for short delay pick-up and time, and include I2t settings.

   c. Breakers shall have individually adjustable ground fault current pick-up and time, and include I2t settings.

5. When the adjustable instantaneous setting is omitted, the trip unit shall be provided with a discriminator or making-current release circuit to prevent closing the circuit

breaker on a faulted system. The circuit shall be armed for approximately eight cycles and shall operate for all fault levels above 11 times the ampere value of the rating plug.

6. An alpha-numeric display shall be provided to indicate the following data:

   a. Instantaneous value of maximum phase and ground current.

   b. Approximate level of fault current that initiated an automatic trip operation.

7. The trip unit shall contain an integral means to conduct circuit breaker tests. A means shall be provided to enable the user to select the values of test currents within the range of available settings. The basic protection functions shall not be affected during test operations.

8. Provide one (1) auxiliary power module for bench testing the trip unit outside the switchgear.

G. Instruments and Sensors:

1. Provide a metering compartment with front hinged door and include the following:

   a. Dedicated Current transformers for metering (can be located separately).
   b. Potential transformers with primary and secondary fuses with disconnecting means (can be located separately).
   c. Connections for extending the potential transformer secondary circuits to remote metering.
   d. Connections for extending the current transformer secondary circuits to remote metering.

2. Square D model 2350 metering package with digital readout capable of displaying the following data:
   - Amperes in each phase
   - Voltage - Phase-to-phase and phase-to-neutral
   - Megawatts
   - Megavars
   - Power Factor
   - Frequency
   - Megawatt Demand
   - Megawatt Hours

3. Current Transformers: ANSI C57.13; 5-ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as shown on the Drawings, with 0.3 accuracy at burden with connected metering and relay devices, 60 Hz. All CT secondary circuits shall be No. 14 AWG wire and shall be terminated on shorting type terminal blocks (GE Type EB 25 or equal) or devices.

4. Voltage Transformers: ANSI C57.13; 120-volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hz.

5. Test Switch and Plug: Provide test switch constructed of molded polycarbonate with screw-type terminals for ring-tongue connectors at rear. Panel mounted on switchgear. Provide short-circuiting current transformer circuits when the knife switches are opened preparatory to inserting the test plug. Switch shall have four potential and six current poles and shall be Westinghouse Type FT-1, Style Number 129A514G01, or equivalent model manufactured by General Electric or Superior. Provide series-type test plug suitable for conducting "in service" testing of potential and current circuits. Test plug shall be Westinghouse Type FT-1, Style Number 292B319G23, or equivalent model manufactured by General Electric or Superior.

H. Accessories:
1. Terminations: Provide mechanical lugs for line and load connections suitable for copper conductors. Lugs shall be suitable for 75 degree C rated conductors.
2. Circuit Breaker Lifting Device: Integral switchgear supported, rail-mounted, elevating hoist on top of the switchgear for movement of circuit breakers in and out of switchboard structure; lifting yoke and hand-cranking device for drawout breakers.
3. Spares: Provide two each spare fuses for each size and type.
4. Nameplates: Provide laminated plastic with engraved letters on each unit. See Section 16195, Electrical Identification.
   a. Provide nameplates for each main, tie, feeder, spare, space, and auxiliary compartment; 1/4-inch minimum character height.
   b. Provide nameplates for each interior and exterior mounted instrument, meter, and/or relay; 1/8-inch minimum character height.
   c. Provide master nameplate for each switchgear lineup; 1-inch minimum character height. Where indicated on the Drawings, provide a separate nameplate for each section of double-ended substations.
   d. Nameplate inscription to be per the Drawings.

I. Finish: Manufacturers standard finish. Finish shall have a minimum dry film thickness of 3 mils; color shall be ANSI 61, Light Grey.

J. Test Kit: Provide a test kit accepted by the breaker manufacturer for testing the breakers and the trip units.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install switchgear in locations shown on the Drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1, under supervision by a qualified factory-trained field engineer, as long as is required to complete final adjustments, inspections, and field acceptance testing.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

3.2 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.

C. Physically test key interlock systems, if present, to ensure proper function.

D. Test low-voltage, metal-clad switchgear in accordance with the requirements of Section 16972, Startup Testing and Commissioning of Electrical Equipment.

3.3 ADJUSTING AND CLEANING

A. Adjust all operating mechanisms for free mechanical movement.

B. Touch up scratched or marred surfaces to match original finish. Repaint entire assembly if required to meet the satisfaction of the Contractor.

END OF SECTION

Technical Specification

Section 16622

Packaged Standby Generator Systems

1 PART 1 GENERAL

1.01 SECTION INCLUDES

A. One engine generator system.

B. Attached radiator.

C. Critical exhaust silencer and fittings.

D. Fuel fittings and day tank.

E. Unit mounted engine generator control panel.

F. Battery and charger.

1.02 PRODUCTS FURNISHED BUT NOT SPECIFIED UNDER THIS SECTION

A. Pipe and Pipe Fittings: Installation of fuel oil and exhaust piping.

B. Fuel Oil System: Installation of fuel oil storage tank tie-in.

1.03 RELATED WORK

A. Basic Mechanical Requirements.

B. Mechanical Sound, Vibration, and Seismic Control.

C. Ductwork.

D. Piping Insulation.

E. Air Outlets and Inlets.

F. Controls and Instrumentation.

G. Automatic Transfer Switches.

1.04 REFERENCES

A. Design, manufacture and test to the latest applicable standards of ANSI, ASTM, NEMA, IEEE and NEC; including, but not limited to, the following:
   1. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. ANSI/NEMA MG 1 - Motors and Generators.
   3. ANSI/NFPA 70 - National Electrical Code.
   4. ANSI/NFPA 99 - Health Care Facilities.
   5. ANSI/NEMA AB 1 - Molded Case Circuit Breakers.
   6. NFPA 110-1988

1.05 SYSTEM DESCRIPTION

A. Engine generator system to provide source of emergency power.

B. System Capacity: 1200 kW, 1500 kVA at elevation of 330 feet above sea level, and ambient temperature between 20 and 104 degrees F (-32 and 40 degrees C); standby rating using engine-mounted radiator.

C. Operation: In accordance with ANSI/NFPA 99. The engine/generator unit shall operate in an automatic mode in conjunction with the Automatic Transfer Switch as described herein:

1. Upon a loss of normal source voltage (any phase of the transfer switch dropping below 70-90 percent adjustable) and after an adjustable time delay period of 0.5-3 seconds to allow for momentary dips, close engine starting contacts to start the engine/generator.
2. When the generator reaches rated speed and frequency, the automatic transfer switch shall transfer to emergency mode.
3. Automatic emergency load acquisition sequence time: Maximum 10 seconds from end of time delay in 1.05 C,1.
4. Upon restoration of normal voltage and frequency (all phases greater than 90 percent of nominal) and after an adjustable time period of 0-25 minutes, retransfer back to normal.
5. After the transfer switch has transferred to normal, the engine/generator shall continue to operate unloaded for 0-5 minutes (adjustable) for engine cool down.

1.06 SUBMITTALS

A. Submit shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.

B. Submit product data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, radiator, and remote annunciator.

C. Submit all specified test reports.

D. Submit certified horsepower curves showing manufacturer's approval of the engine rating for generator set standby use.

E. Submit manufacturer's installation instructions to the design engineer.

1.07 PROJECT RECORD DOCUMENTS

A. Submit five (5) sets of record documents upon completion of initial start-up and system checkout.

B. Accurately record location of engine generator and mechanical and electrical connections.

1.08 OPERATION AND MAINTENANCE DATA

A. Submit five (5) sets of operation and maintenance data manuals upon completion of initial start-up and system checkout.

B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.09 QUALIFICATIONS

A. Manufacturer: Company specializing in packaged engine generator system with minimum ten years documented experience.

B. Supplier: Authorized distributor of engine generator manufacturer with service facilities within 100 miles (160 km) of project site.

C. Reliability Tests:
1. Certified Factory Prototype Model Tests: The power system consisting of prime mover, generator and all necessary controls must be tested as complete systems on representative engineering prototype models. The tests, being potentially damaging to the equipment tested, must not be performed on equipment sold, but on separate prototype models. A certificate certifying that this prototype testing has been accomplished, shall be submitted along with submittal data for approval. Tests include:
   a. Maximum power level (maximum kW).
   b. Maximum motor starting capacity (maximum kVA).

c. Structural soundness.
d. Torsigraph analysis per MIL-STD 705B, method 504.2. Calculate a torsional analysis using data from actual tests by the generator set manufacturer to verify freedom from torsional stresses within +/- 10 percent of rated speed. Make results available to the Engineer for inspection upon request. Actual torsional fatigue test must be performed on the complete prototype generator set. Calculations based on engine and generator data separately are not acceptable.
e. Engine-alternator cooling air flow.
f. Transient response and steady-state governing.
g. Alternator temperature rise by imbedded thermocouples and by resistance method per NEMA MG1-22.40.
h. Harmonic analysis and voltage wave form deviation per MIL-STD 705B, method 601.4.
i. Three-phase short-circuit test for mechanical and electrical strength. With system operating at rated volts, amps, power factor, and speed, the generator terminals must be short circuited ten times on all three phases for a duration of thirty seconds. Generator set must build up and perform normally without manual interventions of any kind such as re-setting of circuit breakers or other tripping devices when the short circuit is removed.
j. Failure mode test for voltage regulator. With generator set operating at no load, rated speed and voltage, the AC sensing circuit to the regulator must be disconnected for a period of at least one hour. The generator set must be fully operative after the test, and without evidence of any kind of damage.
k. Endurance testing at rated load and speed is required without significant damage or failures of electrical or mechanical components.

2. Factory Production Model Tests: Before shipment of the equipment test generator set and system components under rated load and power factor for performance and proper functioning of control and interfacing circuits. Testing at unity power factor only (resistance banks only) is not acceptable. Other tests include:
   a. Single step load pickup per NFPA 76A.
   b. Transient response and steady state governing.
   c. Alternator temperature rise by resistance method.
   d. Functional compatibility between generator set controls and transfer switch controls (start, transfer, retransfer, stop, with all time delays).
   e. Fuel consumption.
3. Notify the Engineer in advance of these tests. Owner or Engineer shall have the option of witnessing these tests.
4. Forward certified copies of test results to the Engineer for review prior to shipment.

1.10 COORDINATION

A. Furnished by same supplier as the automatic transfer switch.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site with the coordination by the Electrical Contractor.

B. Storage and protect of the products shall be the respondsibility of the Electrical Contracor.

C. Accept packaged engine generator set and accessories on site in crates and verify damage.

D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.12 WARRANTY

A. Provide a five year or 1500 hours of operation, whichever occures first, from the time of acceptance. Acceptance occurs when generator has satisfactorily passed all startup and field tests, operates satisfactorily and meets these specifications fully. The entire warrenty shall be supplied by one manufacturer that shall have financial strength and technical expertise to provide adequate warranty support.

1.13 MAINTENANCE SERVICE

A. Furnish service and maintenance of packaged engine generator system for one year from Date of Substantial Completion.

1.14 EXTRA MATERIALS

A. Provide the following spare parts:
   1. 3 sets fuel oil filter elements and gaskets.
   2. 3 lubricating oil filter elements and gaskets.
   3. 1 air cleaner filter element.
   4. 2 sets packing for each auxiliary pump.
   5. 2 sets V-belts for each fan and pump drive.

2 PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cummins Northwest, Inc.

B. Caterpillar.

C. Onan.

2.02 ENGINE

A. Type: Air-cooled inline or V-type, four or two stroke cycle, compression ignition diesel internal combustion engine with removable wet-type cylinder liners.

B. Rating: Sufficient to operate at 10 percent overload for two hours at specified elevation and ambient limits.

C. Fuel System: Appropriate for use of No. 2 fuel oil (ASTM D396).

D. Engine Speed: 1800 rpm.

E. Governor: Electronic speed droop type; speed droop shall be 3 percent; frequency at any constant load, including no load, to remain within a steady state band width of plus or minus 0.25 percent of rated frequency.

F. Safety Devices: Engine shutdown on high jacket water temperature, low lubricating oil pressure, engine overspeed, and engine overcrank. Limits as recommended by manufacturer.

G. Engine Starting: DC starting system with positive engagement, two starter motors, voltage of starter motors in accordance with manufacturer's instructions of sufficient capacity to start the engine within ambient temperatures between 20 and 104 degrees F within the specified time period. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

H. Engine Jacket Heater: Immersion type water heater with integral thermostatic control, sized to maintain engine jacket water at 120 degrees F in an ambient temperature of 20 degrees F, and suitable for operation on 120 volts AC. Heaters shall be thermostatically controlled and provided with a high temperature trip to activate at 150 degrees F to prevent overheating of the engine cooling system.

I. Radiator:
   1. Radiator using solution of 50 percent ethylene-glycol coolant, with blower type fan, sized to maintain safe engine temperature when generator is fully loaded at ambient temperature and altitude specified. Radiator Air Flow Restriction: 0.5 inches of water, maximum.
   2. Provide an engine-mounted cooling radiator with blower fan and venturi shroud. Provide a rigid guard to close both top and sides of all moving parts between the engine and the

radiator. The radiator shall be provided with a duct flange outlet and flexible ducting. The flexible ducting shall be neoprene coated fire-resistant glass fabric, Ventfabrics, Ventglas, Durodyne, Durolon, or approved equal.

3. Design radiator fans for stationary power application with extra quiet tip design; one-piece cast aluminum type. "Truck type" steel stamped or riveted fans not approved.

J. Engine Accessories:
1. Fuel Strainer and Filter: One each mounted between engine fuel pump and engine. Provide indicating pressure gauges on both upstream and downstream side of strainer and filter.
2. Lube Oil Filter: Conveniently located for servicing; equipped with a spring loaded bypass valve to ensure oil circulation if filters are clogged. Provide an oil drain extension line positioned to permit the most convenient possible servicing of the unit as installed. Provide an oil drip pan for mounting underneath the engine. Provide a bayonet type oil level stick.
3. Intake Air Filter: One or more heavy-duty dry-type, replaceable element type rated for normal service with restriction indicators that indicate service life of element.
4. Lubrication-Oil Cooler: Shell-and-tube type, arranged for utilizing engine-cooling water as the oil-cooling medium.
5. Fuel Pump: Positive-displacement engine-driven type to pump the fuel from the day tank to the engine.
6. Water Pump: Engine-driven, centrifugal-type with thermostatic valve to maintain the engine at the recommended temperature level. Provide side stream type engine water filters to treat coolant and prevent corrosion and scale deposits within the cooling system.
7. Lubricating Oil Pump: Gear-type for supplying oil under predetermined constant pressure to but not limited to main bearings, pistons, piston pins, timing gears, camshaft bearings and valve mechanism.
8. Oil: Provide unit filled with initial fill of manufacturer's specified engine oil.
9. Fuel Oil Separator: Provide "RACOR" (metal) water separator upstream of the fuel pump.

K. Engine Fault Indicators: At the engine generator control panel, provide two (2) sets of 5A, 120V form C dry contacts for remote annunication of:
1. Low lubricating oil pressure
2. Lubricating oil filter relief valve open
3. High jacket water temperature
4. Low jacket water temperature
5. Approaching high jacket water temperature
6. Approaching low lubricating oil pressure
7. Engine overspeed
8. Engine overcrank
9. Low fuel level in day tank
10. High fuel level in day tank
11. Low battery voltage
12. Engine control switch not in auto position
13. High oil temperature.
14. Pyrometer with cylinder selection and total exhaust temperature.

L. Meet all applicable federal, state, and local air emission standards.

M. Subbase: Mount engine and generator on common structural steel frame sufficiently rigid to prevent deflection between vibration isolators.

2.03 GENERATOR

A. Generator: ANSI/NEMA MG1; reconnectable brushless, revolving field type, coupled directly to the engine flywheel through a flexible driving disc for positive alignment. Directly bolt generator housing to engine flywheel housing. Generator housing to have a single ball bearing support for the rotor.

B. Rotor: Layer wound with thermo-setting epoxy between each layer plus a final coat of epoxy for moisture and abrasion resistance; Amortisseur windings integral with the rotor coil support; Shaft bearing shielded type with provisions for easy servicing through grease pipes which extend to the exterior of the generator frame; bearing designed for a minimum B-10 bearing life of 40,000 hours; Dynamically balanced up to 25 percent overspeed.

C. Stator Winding: Two-third pitch design to eliminate third harmonic waveform distortion and minimize the harmful neutral circulating current. Windings to have five dips and bakes of varnish plus a final coating of epoxy for moisture and abrasion resistance; Waveform harmonic distortion: not over 5 percent total rms measured line to line at rated load.

D. Ratings: Engine-generator manufacturer to determine the required kW, and kVA rating for the specified worst case motor starting loading and the specified worst case steady state loading. Provide satisfactory performance under both loading conditions, not occurring simultaneously. Voltage **dip** during motor starting not to exceed 20 percent.

1. Worst case motor starting condition shall be the most severe of the following case:

a. The engine generator must be able to start two 75 hp motor while supplying a steady state load of 290 kW at 0.9 power factor, 200 kW of which is a 0.8 power factor.

b. The motor starting sequence will be as follows. Immediatly after normal power failure, three 25HP air conditioning unit motors, and two 165HP exhaust unit motors will be stagger started with a starting interval of 10 seconds.

2. Rating: Minimum 1200 kW, 1500 kVA, at 0.8 power factor, 480 volt volts, 60 Hz three phase, 3-wire, six pole at 1800 rpm.

E. Refer to all other divisions of the Specifications and the Drawings, particularly the one-line diagrams and provide a coordinated system.

F. The generator rating applicable for continuous service in a stand-by power application and in conformance with all applicable NEMA standards, latest revision.

G. Insulation: ANSI/NEMA MG 1, Class F.

H. Temperature Rise: 105 degrees C continuous.

I. Weather Protective Housing Enclosure: The generator set shall be enclosed in a weather protective housing constructed of heavygauge reinforced sheet steel. The housing shall be attached to the generator mounting base and radiator cowling. The housing shall provide easy access to the generator set by two removable panels on each side. A rear hinged door with key locking handle shall be provided for easy access to the control panel. The exhaust system specified shall mount horizontally in the housing with heat shields and brackets. Limit the step into the enclosure to a height of 18 inches.

J. Voltage Regulation: Include solid-state generator-mounted volts per Hertz exciter-regulator with SCR control to match engine and generator characteristics, with voltage regulation +/- one percent from no load to full load. Include manual controls to adjust voltage drop +/- 5 percent voltage level, and voltage gain. Voltage dip during motor starting not to exceed 20 percent. Basler Type SR8F3 or approved equal.

K. Rotating Brushless Exciter: Incorporate a full wave, three phase rotating rectifier with hermetically sealed, metallic type, silicon diodes to supply main field excitation. Connect multiplate selenium surge protector across the diode network to protect it against transient conditions.

L. Telephone influence factor (TIF): Not to exceed 50.

M. Furnish an end mounted, ventilated load connection box such that load conductors can enter the top of the junction box.

2.04 ACCESSORIES

A. Fuel System:

1. In-Skid Fuel Tank: Tank shall be equipped for automatic unattended operation, with float switch. The fuel tank shall be a standard product of the manufacturer of the engine-generator set. The tank shall be factory installed in the generator set skid base with engine supply and return lines per-plumbed and shall not extend beyond the outside dimension of the skid base; 1000 gallon including:
   a. Two inch manual fuel fill tube with screw-on type vented cap.
   b. Low fuel level switch and alarm contacts for remote annunciation.
   c. Built to UL and NFPA specifications.
   d. High fuel level switch and (2) sets of 5A, 120V form C dry alarm contacts for remote annunciation.
   e. Sight glass with shutoff cocks.
   f. Double wall construction tank with alarms.
2. Wire reinforced flexible fuel lines with threaded connections and swivel fittings for each fuel connection on the engine.
3. Provide the diesel engine manufacturer's standard fuel system, including a replaceable spin-on type fuel filter conveniently located for servicing.

B. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation. Size and select the silencer and exhaust pipe size so the pressure loss does not exceed the manufacturer's recommended maximum. Provide a stainless steel, flexible, corrugated pipe for each exhaust outlet between engine and silencer, minimum 24 inches long. The pipe shall be especially suited for diesel exhaust service. Provide an exhaust condensation trap with manual drain valve to trap and drain off exhaust condensation and to prevent condensate from entering the engine. System derived noise shall measure less than 85 dBA at 20 feet.

C. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 200 ampere-hours minimum capacity. Capacity sufficient for no less than six 10 second starting attempts in specified ambient range. Match battery voltage to starting system. Include necessary cables and clamps.

D. Battery Tray: Plastic coated metal or wooden tray treated for electrolyte resistance, constructed to contain spillage of electrolyte.

E. Battery Charger: Provide the floating type, suitable for operation on 120 volt power with adjustable charging rate. It shall be separately mounted from the engine generator stud. Provide ammeter to indicate change which is mounted on the battery charger feed. Provide low battery voltage alarm contacts for remote annunciation. LaMarche, Model 4-46, or approved equal. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide built-in equalizer charge timer. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.

F. Line Circuit Breakers: NEMA AB 2 molded case circuit breakers on the generator output,(1) 800A trip and (1) 600A trip both breakers shall be 100% rated, and have integral thermal and instantaneous magnetic trip in each pole sized in accordance with ANSI/NFPA 70. Include battery-voltage operated shunt trip, connection to open circuit breaker on engine failure. Mount unit in enclosure to meet ANSI/NEMA 250, Type 1 requirements.

G. Remote Alarm Annunciator: Provide (2) audible and visible remote alarm annunciator panels for the engine-generator malfunctions. The annunciator shall have the features:
   1. High Battery Voltage.
   2. Low Battery Voltage.
   3. Normal Battery Voltage.
   4. Generator Running.
   5. Normal Utility Power.
   6. EPS Suppling Load.
   7. Pre-Low Oil Pressure.
   8. Low Oil Pressure.
   9. Pre-High Coolant Temperature.

10. High Coolant Temperature.
11. Low Engine Temperature.
12. Overspeed.
13. Overcrank.
14. Not In Automatic.
15. Battery Charger Malfunction.
16. Low fuel.
17. Fault.

H. Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:
1. Frequency Meter: 45-65 Hz range, 3-1/2 inch dial.
2. AC Output Voltmeter: 3-1/2 inch dial, 2 percent accuracy, with phase selector switch.
3. AC Output Ammeter: 3-1/2 inch dial, 2 percent accuracy, with phase selector switch.
4. Output voltage adjustment.
5. Push-to-test indicator lamps, one each for low lubrication oil pressure, high jacket water temperature, engine overspeed, engine overcrank, low fuel level in day tank, high fuel level in day tank, low jacket water temperature, approaching high jacket water temperature, approaching low oil pressure, low battery voltage, engine control switch not in auto position, and high oil temperature.
6. Engine start/stop selector switch and emergency stop pushbutton.
7. Engine running time meter.
8. Lubricating oil pressure gage.
9. Cooling water temperature gage.
10. Fuel oil pressure gauge.
11. Lubricating oil temperature gauge.
12. Direct reading indicating tachometer.
13. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
14. Remote Alarm Contacts: Pre-wire DPDT contacts to terminal strip for remote alarm functions listed in 5. above.

I. Factory Paint: The complete engine generator set, including the instrument panel, shall be given a factory-applied primer and two finish coats of the manufacturer's standard heat resistant engine paint. The color shall be as selected by the Owner.

3 PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work and field dimensions are as shown on Drawings.

B. Verify that required utilities are available in proper location and ready for use.

C. Beginning of installation means installer accepts existing conditions.

3.02 FACTORY BALANCE

A. Factory balance entire engine generator package for Mechanical Sound, Vibration, and Seismic Control.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide minimum 4 inch deflection Type C vibration isolation mount and snubbers as required.

C. Provide flexible conduit and pipe connections to vibration isolated generator.

D. Provide a critical grade muffler for emergency generator exhaust.

3.04 FIELD QUALITY CONTROL

A. Field inspection and testing will be witnessed by the engineer.

B. Provide full load test utilizing portable test bank, if required, for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal. Schedule this test with the Owner so he can arrange witnessing. Procedure to be submitted for approval.

C. During test, record the following on calibrated strip charts:
1. Kilowatts.
2. Amperes.
3. Voltage.
4. Coolant temperature.
5. Room temperature.
6. Frequency.
7. Oil pressure.
8. Power factor.

D. Test alarm and shutdown circuits by simulating conditions.

3.05 MANUFACTURER'S FIELD SERVICES

A. Provide a factory qualified erection engineer to personally supervise the complete installation of the diesel engine and generator including setting, alignment, assembly, connections, startup, testing, and instruction of Owner's representative. Furnish the manufacturer's written certification assuring that each item of equipment is complete, in good condition, free from damage, and properly installed, connected, and adjusted.

3.06 ADJUSTING

A. Adjust generator output voltage and engine speed as require to carry the design building load.

3.07 CLEANING

A. Clean engine and generator surfaces. Replace lubricating oil and fuel filters.

3.08 DEMONSTRATION

A. Provide system demonstration.

B. Describe loads connected to emergency system and restrictions for future load additions.

C. Simulate power outage by interrupting normal source, and demonstrate that system operates to provide emergency power.

D. Instruct Owner's representative for a period of no less than 2 days in maintenance and operation of equipment, including not less than four complete sets of operating and maintenance manuals.

END OF SECTION

Technical Specification

Section 16624

Automatic Transfer Switches

1 PART 1 GENERAL

1.1 WORK INCLUDED

A. Automatic transfer switches.

1.2 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for automatic transfer switches:
   1. Section 16010 - Basic Electrical Requirements.

2 PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Onan

B. ASCO Controls Inc.

2.2 AUTOMATIC TRANSFER SWITCHES

A. Automatic transfer and bypass/isolation switch shall be the product of 1 manufacturer and be completely factory interconnected and tested so only line and load connections to bypass/isolation switch are required for field installation. Interconnections between transfer switch, bypass switch, and isolations switch shall be by siliver-plated copper bus bar. Prominent and detailed instruction plate shall be provided. Enclosure construction shall be in accordance with UL and NEMA Standards for industrial controls.

B. Inphase Monitor: Provide inphase monitor circuitry built in to the ATS. The inphase monitor shall operate without-external control of electrical loads and without any external control of the power sources. The monitor shall compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency difference. Inphase transfer shall be accomplished if both sources are within 2 Hz of nominal frequency and 70 percent or more nominal voltage.

C. Switch shall be rated for continuous duty for all classes of loads in an unventilated sheet metal enclosure.

D. Provide quantity indicated on the Drawings.

E. Short circuit withstand capability as indicated on the Drawings. If not indicated on the drawings, minimum short circuit withstand capability shall be 50KA.

F. Transfer Mechanism:
   1. Dual, momentarily energized electric operator to activate a double-throw switch.
   2. Provide quick-make, quick-break switch contacts.
   3. Capable of operating at 70 percent of nominal system voltage.
   4. Interlocked normal and emergency contacts (mechanically and electrically) to prevent simultaneous closing.
   5. Silver-tungsten alloy main contacts mechanically held without the use of hooks, latches, magnets or springs.
   6. Separate arcing contacts and arc extinguishing chutes.

G. Switch shall operate automatically to transfer load to emergency source when any phase of the normal drops below preset voltage (75 to 98 percent of pick up value) and to permit retransfer load back to normal when all phases are restored to preset voltage (85 to 95

percent of rated voltage). Factory settings shall be 80 percent for drop-out and 90 percent for pick-up.

H. Operating current for transfer shall be obtained from source to which load is to be transferred. Failure of any coil or disarrangement of any part shall not permit a neutral position.

I. Manual Operator: capable of actuating the switch with the same action and speed as the electric operator.

J. Enclosure:
   1. NEMA 1.
   2. Finish: manufacturer's standard.

K. Transfer Inhibit, Load Shed: circuitry that prevents transfer of load from emergency to normal or normal to emergency when system capacity is not available.

L. Where neutral conductor is indicated, provide overlapping neutral pole where neutral connections are made before phase connections are made, and opened after phase connections are opened. Two neutrals shall be paralleled for less than 5 cycles.

M. Settings:
   1. Time delay 0.5 to 3 seconds on engine-start signal, factory set for 1.0 second.
   2. Time delay adjustable 2 to 30 minutes on retransfer with 5 minutes unloaded running time, factory set for 30 minutes.
   3. Other settings shall be made as indicated on the drawings.

N. Switches shall have factory warranty of 1 year from Date of Acceptance.

2.3 BYPASS ISOLATION SWITCH

A. Fully rated, manually operated.

B. Rated for same loads, withstands, and voltages as automatic transfer switch with which it is used, as indicated on the Drawings.

C. Bypass to either normal or emergency source by use of a selector switch and a permanently mounted external lever. Bypass of load to either normal or emergency power source with complete isolation of automatic transfer switch to be possible regardless of status of automatic transfer switch; electrical bypass and isolation of automatic transfer switch shall be possible without interrupting load.

D. Bypass switch shall function as manual transfer switch to allow load transfer to either source of power regardless of position or condition of transfer switch, including condition when automatic transfer switch is removed, and without reconnecting load terminals of automatic transfer switch.

E. Quick-make, quick-break contact action shall prevent partial transfer.

2.4 AUTOMATIC TRANSFER SWITCH ACCESSORIES

A. Provide one normally open and one normally closed contact, rated 5A at 120 Vac, for interface with the facility management system (FMS) for each of the following:
   1. Loss of normal voltage (voltage sensing relay on normal source).
   2. Emergency source detected at line side of transfer switch (voltage sensing relay on emergency source).
   3. Transfer switch in normal position.
   4. Transfer switch in emergency position.
   5. Transfer switch in bypass to normal position.
   6. Transfer switch in bypass to emergency position.
   7. Transfer switch in neutral position.

B. All alarm contacts shall be fail-safe, configured from the factory, incorporated into the equipment's controls, not added on in the field with additional relays. The correct operation shall be energized relay in the equipment to maintain a set of normally open contacts closed as long as there is no alarm. This will provide an energized signal to the FMS and will cause an alarm if any of the following conditions exist:
   1. The power is lost to the equipment.
   2. The physical wire connection is lost.
   3. The equipment is in alarm.
   4. The fuse in the PLC blows.
   5. The battery voltage is low.

C. Provide one red and one green indicating light on enclosure door.
   1. Green light illuminated when switch is in normal position.
   2. Red light illuminated when switch is in emergency position.

D. Provide three amber indicating lights on enclosure door.
   1. One light illuminated when normal source is present.
   2. Second light illuminated when emergency source is present.
   3. Lights operate from voltage sensing relays, not directly from main busses.
   4. Third light illuminated when ATS is in bypass position.

E. Identify all control wire terminations with tubular sleeve-type markers.

F. Auxiliary, supervisory, and other control wiring shall terminate on identified terminal strips accessible when switch is energized.

G. Automatic transfer switches shall include internal and interconnecting wiring as required.

H. Provide schematic drawing under clear plastic on interior of enclosure door.

I. Meters: Series power monitor.

J. Engine Generator Exercise Timer: An engine generator exercising timer shall be built-in to the ATS control module and shall include a selector switch to select exercise with or without load transfer. The exerciser shall be solid-state for maximum reliability and minimum

maintenance and shall be programmable to enable exercise for 1 minute to 24 hours per day (in 1-minute increments) for 0 to 7 days per week. Exercise settings shall be set by pushbutton and a digital display shall be provided to indicate settings. A replaceable, built-in battery shall be provided to enable the exerciser to continue to operate for up to two weeks without external power. A built-in battery charger shall extend battery life to at least five years. Loss of the battery shall not disable the exercise function as long as normal power is present.

2.5 AUTOMATIC TRANSFER SWITCH CONTROL DEVICES

A. Three-position switch mounted on enclosure door with three modes as follows:
   1. Off:
      a. Control relays de-energized. No operation under any circumstances.
      b. Provide white, door-mounted indicating light illuminated when in "off" position.
   2. Auto: Complete automatic operation as specified.
   3. Test: Simulates failure of normal source - transfer to emergency as specified. Retransfer to normal after switch is returned to AUTO position after appropriate time delay (provide momentary contact switch to override time delay from emergency to normal).

B. Switch and relay contacts, coils, springs, and control elements shall be removable from front of transfer switch without removal of switch panels from enclosure and without disconnection of drive linkages or power conductors. Sensing and control relays shall be continuous-duty industrial-control type with minimum contact of 10 amperes.

2.6 ACCESSORIES - GENERAL

A. Ramp: Provide ramps for removal of transfer switch assembly from enclosure if specified on the drawings.

B. Transfer Neutral Alternate: Provide additional cost for neutral position off with the Bid. Switch shall transfer from emergency source to a neutral position for shedding noncritical loads if specified on the drawings.

C. Terminations: Provide all hardware as required to accommodate the type of connectors specified on the one line drawing.

D. Nameplates: laminated plastic with engraved letters on each unit. Refer to detailed design drawings.

3 PART 3 EXECUTION

3.1 INSTALLATION

A. Install automatic transfer switches in accordance with manufacturer's instructions.

3.2 ADJUSTING AND CLEANING

A. Adjust contactors, time delays, and all functioning parts.

B. Clean all exterior and interior surfaces.

3.3 DEMONSTRATION

A. Provide a factory-trained field representative to instruct the Owner's personnel for a period of no less than 1 day in maintenance and operation of the equipment.

3.4 CLOSEOUT

A. In addition to the requirements of Section 16010, Basic Electrical Requirements, provide the Owner two copies of ATS control settings including comments regarding factory settings.

END OF SECTION

Technical Specification

Section 16721

Fire Alarm Systems

1 PART 1 GENERAL

SECTION INCLUDES

Fire alarm control panels.

Manual fire alarm stations.

Automatic smoke, duct, and heat detectors.

Fire alarm signaling appliances.

Auxiliary fire alarm equipment.

RELATED SECTIONS

Section 16010 – Basic Electrical Requirements.

Section 16123 - Building Wire and Cable.

CODES AND STANDARDS

NFPA 70 - National Electrical Code.

NFPA 72 – National Fire Alarm Code.

NFPA 101 - Life Safety Code.

UBC – Uniform Building Code.

UFC – Uniform Fire Code.

ADA – Americans with Disabilities Act

G. State and Local Codes

SYSTEM DESCRIPTION

Provide a complete non-coded, supervised, analog addressable, 24 volt DC fire alarm system as indicated on the drawings and specified herein. Provide connections to a local central station within the City of Richland, Washington. The contractor shall provide the system including all equipment and programming required for the complete system. Equipment shall include fire alarm panels, smoke detectors, duct detectors, heat detectors, voice evacuation speakers, strobes, audio preamplifiers and power amplifiers, power supplies, microphone, batteries and other equipment as required.

SUBMITTALS FOR REVIEW

Product Data: Provide electrical characteristics and connection requirements.

Shop Drawings: Indicate annunciation layout and system wiring diagram showing each device and wiring connection required.

SUBMITTALS FOR INFORMATION

Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

QUALITY ASSURANCE

Conform to requirements of NFPA 70 and NFPA 101.

Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum six years documented experience, and with service facilities within 250 miles of Project.

Supplier Qualifications: Authorized distributor of specified manufacturer with minimum six years documented experience.

Installer Qualifications: Company specializing in installing the products specified in this section with minimum six years documented experience, and certified or licensed by the State of Washington as a fire alarm installer.

Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

MAINTENANCE SERVICE

Provide service and maintenance of fire alarm equipment for one year from Date of Substantial Completion.

EXTRA PRODUCTS

Furnish two manual station keys.

Furnish six keys of each type.

Furnish three of each type of automatic smoke detector [without base].

A PART 2 PRODUCTS

MANUFACTURERS

Pyrotronics Inc.

Approved Equal

FIRE ALARM CONTROL PANEL AND ANNUNCIATOR

Control Panel: Modular construction with flush wall-mounted enclosure. Enclosure shall be sized to allow for 100% expansion capability.

Power supply: Adequate to serve control panel modules, remote detectors, remote annunciator, and alarm signaling devices. Include battery-operated secondary power supply with capacity for operating system in standby mode for 48 hours followed by alarm mode for 10 minutes.

System Supervision: Component or power supply failure places system in trouble mode.

Alpha/numeric 80 character display

Paging microphone and switches.

Initiating Device Circuits: Supervised zone module with alarm and trouble indication; occurrence of single ground or open condition places circuit in trouble mode but does not disable that circuit from initiating an alarm. Initiating circuits shall have 20% spare capacity after system completion.

Indicating Appliance Circuits: Supervised signal module, sufficient for signal devices connected to system; occurrence of single ground or open condition places circuit in trouble mode but does not disable that circuit from signaling an alarm.
Audible device wattage taps shown on floor plans are preliminary. Field adjust all device output levels to meet ambient noise conditions. Audible circuits as shown on the drawings shall have 50% spare capacity to accommodate field adjustments.
Visual device circuits shall have 20% spare capacity after system completion.

Remote Station Signal Transmitter: Electrically supervised digital alarm communicator transmitter, capable of transmitting alarm and trouble signals over telephone lines to central station receiver.

Auxiliary Relays: Sufficient SPDT auxiliary relay contacts for each detection zone to provide accessory functions specified.

TROUBLE ACKNOWLEDGE, DRILL, and ALARM SILENCE switch.

Trouble Sequence of Operation: System or circuit trouble places system in trouble mode, which causes the following system operations:
Visual and audible trouble alarm indicated by zone at fire alarm control panel.
Visual and audible trouble alarm indicated at remote annunciator panel.
Trouble signal transmitted to central station.
Manual acknowledge function at fire alarm control panel silences audible trouble alarm; visual alarm is displayed until initiating failure or circuit trouble is cleared.

Alarm Sequence of Operation: Actuation of initiating device places circuit in alarm mode, which causes the following system operations:
Sound and display local fire alarm signaling devices with march time signal.
Transmit zone-coded signal to central station.
Indicate location of alarm zone on fire alarm control panel and on remote annunciator panel.
Transmit signal by zone to building smoke removal system.
Transmit signal to building mechanical systems to initiate shutdown of fans and damper operation.
Transmit signal to release door hold-open devices by zone.

Alarm Reset: System remains in alarm mode until manually reset with key-accessible reset function; system resets only if initiating circuits are out of alarm mode.

Lamp Test: Manual lamp test function causes alarm indication at each zone at fire alarm control panel and at annunciator panel.

Drill Sequence of Operation: Manual drill function causes alarm mode operation as described above.

Zoning: As indicated on the detailed drawings.

Remote Annunciator: A surface mounted factory enclosure. Enclosure shall be sized to allow for 100% expansion capability. Supervised remote annunciator including audible and visual indication of fire alarm by zone, and audible and visual indication of system trouble. A paging microphone and switches shall be included. Coordinate location and additional functionality requirements such as fan control with the Authority Having Jurisdiction.

INITIATING DEVICES

Manual Station: Surface mounted, non-coded type, single action manual station. Provide manufacturer's standard backbox.

Spot Heat Detector: Combination rate-of-rise and fixed temperature, rated as specified on the Drawings, and temperature rate of rise of 15 degrees F (8.3 degrees C)

Ceiling Mounted Smoke Detector: Photoelectric type with adjustable sensitivity, plug-in base, auxiliary relay contact, integral thermal element, and visual indication of detector activation, suitable for mounting on 4 inch (102 mm) outlet box.

Duct Mounted Smoke Detector: Photoelectric type with auxiliary SPDT relay contact, remote key-operated NORMAL-RESET-TEST switch, duct sampling tubes extending width of duct, and visual indication of detector activation, in duct-mounted housing.

Flame Detector: Infrared/ Ultraviolet type.

SIGNALING APPLIANCES

Alarm Lights: Light intensity complying with the ADA act, Xenon strobe lamp with unfiltered or clear filtered white light. Red lettered "FIRE" on white lens.

Alarm Speakers: Surface type fire alarm speaker. Sound Rating: 100 dB at 10 feet (3 M). Field selectable power taps of 1, 2, 4, 7, and 15 watts, red in color. Provide dual cone speakers for shared use with the paging system.

B PART 3 EXECUTION

INSTALLATION

Install manual station with operating handle 48 inches above floor. Install audible devices 96 inches and visual devices 80 inches above floor.

Install 16 AWG minimum size conductors for fire alarm detection and signal circuit conductors in conduit. Refer to Section 16123, Wire and Cable.

Mount end-of-line resistor on last device .

Mount outlet box for electric door holder to withstand 80 pounds pulling force.

Connect conduit and wire to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control panels, and other devices as required.

Installation shall conform to NFPA 72.

FIELD QUALITY CONTROL

Quality Assurance, starting of systems, field inspection, testing, adjusting to be performed with the design engineer as a witness.

Test in accordance with NFPA 72 and local fire department requirements.

MANUFACTURER'S FIELD SERVICES

Include services of certified technician to supervise installation, adjustments, final connections, and system testing.

DEMONSTRATION AND INSTRUCTIONS

Demonstrating installed work.

Demonstrate normal and abnormal modes of operation, and required responses to each.

END OF SECTION