PART 1 GENERAL

1.01 SCOPE
   A. The medium voltage switchgear and bus duct shall be equipped with partial discharge sensors and a partial discharge continuous monitor.

1.02 RELATED SECTIONS
   A. Section 16341 – Metal-Enclosed Bus Duct – Medium Voltage
   B. Section 16346 – Metal-Clad Switchgear
   C. Section 16347A – Metal-Enclosed Switchgear Medium Voltage Fixed Mount
   D. Section 16347B – Metal-Enclosed Switchgear Medium Voltage Drawout
   E. Section 16955 – Electrical Equipment Acceptance Testing and Startup

1.03 REFERENCES
   A. All sensors and monitors shall have UL/CSA/CE certification.

1.04 SUBMITTALS – FOR REVIEW/APPROVAL
   A. This equipment is an integral part of the bus duct and switchgear and is subject to the submittals specified with the related product.

1.05 SUBMITTALS – FOR CONSTRUCTION
   A. This equipment is an integral part of the bus duct and switchgear and is subject to the submittals specified with the related product.

1.06 QUALIFICATIONS
   A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
   B. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
   C. The manufacturer and service organization of the equipment shall have been regularly engaged in the manufacture & service of medium voltage equipment this is to be installed in for a period of at least thirty (30) years and demonstrate that these products have been utilized in satisfactory use in functioning systems for similar applications. The service
organization shall be familiar with interpreting, servicing, and maintaining this increased sophistication level of switchgear for at least five (5) years.

D. The manufacturer shall have a minimum net worth of $500 million to ensure financial stability during and after the completion of the retrofit process.

1.07 REGULATORY REQUIREMENTS

1.08 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer’s instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.09 OPERATION, MAINTENANCE MANUALS AND SOFTWARE

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

B. All end user software shall be provided on a compact disk and shipped with the equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton

B. 

C. 

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 PARTIAL DISCHARGE SENSING EQUIPMENT FOR MEDIUM VOLTAGE SWITCHGEAR

A. All medium voltage switchgear lineups shall be equipped with Partial Discharge Sensors to measure partial discharges within the cubicles. The sensing technology shall provide measurement of all discharges through the direct sensing of the electromagnetic wave generated by a partial discharge.

B. Measurements shall be performed on-line, while switchgear equipment is energized under normal operational conditions, using measurement equipment specifically designed for this purpose.

C. Partial Discharge Sensors

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*Note to Spec. Writer – Insert data in blanks*
1. Partial Discharge (PD) sensors shall detect partial discharges through sensing of the electrical impulses generated by partial discharges (including corona, surface tracking or minute sparks in insulation voids, as well as arcing and sparking).

2. Sensitivity of PD sensors and measurement technology must be sufficient to detect early stages of defect development by measuring PDs of low levels (less than 50 pico-coulombs). PDs occurring within the cubicles as well as PDs emanated by external sources (cable terminations, cables, bus ducts, connected transformers, motors, etc.) within the short distance thereof and appearing at the PD sensors must be sensed.

3. Where indicated on the drawings, the sensors shall also be connected to a Cutler-Hammer type InsulGard Relay.

D. PD sensor connections and installation

1. Three 80 pF coupling capacitors shall be mounted and be connected phase to ground in a minimum of every third structure (one per phase). Refer to drawings for additional sensor location requirements. These connections need to be low in inductance. Use of #3 AWG or larger wire is recommended. This wire must be rated for operating voltage and may be unshielded. An adequate ground must be supplied to each CC to ensure a low inductance path. Actual placement will be based the physical layout of the switchgear.

Each sensor shall be wired to a central location and connected to the PD Relay specified in 2.02. Refer to drawings for sensor location. For safety considerations, the coupling capacitor must be grounded at the point of installation. Grounding the capacitor at the instrument or termination box is not acceptable.

2. If the switchgear consists of more than six structures, it is not acceptable to apply only two sets of coupling capacitors on either end of the switchgear. Sensing for partial discharges at the ends of the switchgear lineups only shall not be considered acceptable unless the lineup is less than 6 cubicles.

3. If specified, each incoming and feeder cable, the cable drain shield shall pass through a Radio Frequency Current Transformer (RFCT) prior to grounding the shield. The secondary winding of the RFCT shall be wired to a central point and connected to BNC connectors and be available for future diagnostic capabilities or can be connected to a PD Relay specified in 1.02 to monitor PD activity in the cable. Instructions shall be provided with the switchgear for proper installation of the partial discharge sensors on the cable shields.

4. A voltage reference source must be available in the switchgear such as a potential transformer. If one does not exist a voltage reference sensor must be installed on one of the PD sensors.

5. Sensing equipment shall be Cutler-Hammer, or approved equal.

2.03 PARTIAL DISCHARGE (PD) RELAY

A. Furnish and install where shown on the drawings a Cutler-Hammer type InsulGard Relay. Installation shall be complete including mounting relay(s) and wiring of all required connections to partial discharge sensors and outputs. PD relay shall be capable of providing
predictive on line alarm and protection for partial discharge induced insulation deterioration resulting from voids, cracks and/or surface tracking or corona activity.

B. Partial Discharge relay shall have the following inputs:
   1. Fifteen (15) input PD signal channels
   2. One (1) noise channel
   3. Three (3) Analog inputs for temperature, humidity and other specified parameters

C. Partial Discharge relay shall have the following outputs:
   1. Two (2) dry contacts for alarm function
   2. One (1) dry contact for indicating system status
   3. One 4 – 20ma signal to indicate the percentage of the channel with the highest partial discharge activity as it relates to the alarm set point
   4. RS-485 connection with Modbus RTU protocol for networking and remote communications

D. Partial Discharge Relay features:
   1. Digital display on the unit which cycles through each monitored channel
   2. Built in noise rejection algorithms
   3. Dedicated noise channel were identified noise requires cancellation
   4. PD relay shall be capable of utilizing inputs from all types and manufacturers of Radio Frequency partial discharge sensors, coupling capacitors, radio frequency current transformers, Rogowski coils, radio frequency voltage sensors and existing RTDs that are in rotating equipment
   5. Suitable for use in operating temperature range from $-40^\circ C$ to $+85^\circ C$
   6. Provide a suitable modem for remote communications and access to the relay, if specified

E. Partial Discharge relay shall be programmable from front keypad and display.
   Programmable features shall include:
   1. Each channel individually programmable
   2. Low level noise levels shall also be programmable for each channel
   3. Programmable continuous high PD level monitor
   4. Display shall be able to be programmed to continuously cycle current information, machine parameters, and last PD readings
   5. Based on typical relay monitor set for 4 times per day, PD relay shall have up to 2000 days of onboard data storage. Frequency of collecting monitored test data shall be programmable. It shall be capable of being collected at preset fixed times or fixed time base
   6. Each PD channel shall have complete setting independence including warning and alarm thresholds for each of two (2) partial discharge parameters (PD Intensity and PD Magnitude)
7. The device shall have the ability to alarm based on the trend of the PD activity over time. This trending shall be performed automatically by the device, once an 8-week baseline as been established.

8. More than one switchgear lineup can be monitored with a single relay (up to 15 PD sensors inputs are available. The maximum distance between the sensors and the relay is 150 feet.

F. Partial Discharge relay shall be provided with the following software:

1. Software must be Microsoft Windows-based and have the ability to download the data directly from the relay monitor or remotely via a modem (land line or cellular).

2. The software shall be able to display graphical trending of partial discharge quantities over time including:
   a. Pulse magnitude
   b. Pulse repetition rate
   c. Partial discharge intensity which shall be a value directly related to the amount of energy in the discharge
   d. Temperature and humidity and air moisture content
   e. Correlation charts that graphically show the correlation coefficients of Temperature and humidity with the quantities listed in a, b and c. above
   f. Phase resolved data in a graphical format

3. The user shall have the ability to graphically compare data between channels as well as correlate the partial discharge quantities to the monitored environmental factors such as temperature and humidity.

PART 3  EXECUTION

3.01  FACTORY TESTING

A. The factory must verify and record continuity of all connections between sensors and monitor.

B. The factory must perform baseline partial discharge tests on the equipment prior to shipment.

C. The factory must verify proper operation of the monitor prior to shipment.

3.02  FIELD TESTING

A. The field engineering service testing group shall provide all material, equipment, labor and technical supervision to perform such tests and inspections.

B. Calibration of the system must take place in the field after all cables are installed and prior to energizing equipment. Calibration is to performed by injecting simulated partial discharges pulses into each feeder and main and verifying response at the monitor.

C. After energizing the main equipment, baseline measurements and final startup procedures should be performed.
D. Upon completion of the tests and inspections noted in these specifications, a label shall be attached to all serviced devices. These labels will indicate date serviced and the engineering service testing group responsible.

E. The tests and inspections shall determine suitability for initial continued reliable operation.

3.03 REMOTE MONITORING DIAGNOSTICS SERVICE

A. Vendor must supply services to remotely monitor each PD relay on an annual contract basis.
   
   1. Each PD relay must be accessed remotely on a minimum of a weekly basis and data uploaded
      a. Vendor must review data and inform owner of any significant changes or new developments in PD activity.
   
   2. Vendor must submit a formal biannual report for each piece of equipment monitored by each PD Relay. This report must detail the following:
      a. Trends of PD activity for each channel
      b. Dependencies of PD activity with Temperature, Humidity and Load for each channel
      c. Review of phase resolved data and analysis of the fingerprints
      d. Assessment as to the overall condition of the equipment and any recommendations.

*Note to Spec. Writer – Optional