

Schneider Electric

POWER DISTRIBUTION UNIT (PDU), 400/500 kVA.

THIS GUIDE SPECIFICATION IS WRITTEN IN ACCORDANCE WITH THE CONSTRUCTION SPECIFICATIONS INSTITUTE (CSI) MASTERFORMAT. THIS SECTION MUST BE CAREFULLY REVIEWED AND EDITED BY THE ARCHITECT OR THE ENGINEER TO MEET THE REQUIREMENTS OF THE PROJECT. COORDINATE THIS SECTION WITH OTHER SPECIFICATION SECTIONS IN THE PROJECT MANUAL AND WITH THE DRAWINGS.

WHERE REFERENCE IS MADE THROUGHOUT THIS SECTION TO "PROVIDE", "INSTALL", "SUBMIT", ETC., IT SHALL MEAN THAT THE CONTRACTOR, SUBCONTRACTOR, OR CONTRACTOR OF LOWER TIER SHALL "PROVIDE", "INSTALL", "SUBMIT", ETC., UNLESS OTHERWISE INDICATED.

THIS SECTION IS WRITTEN TO INCLUDE THE 2004 MASTERFORMAT AND THE 1995 MASTERFORMAT VERSIONS. WHERE APPLICABLE, THESE ITEMS ARE BRACKETED AND, IN EACH CASE, UNLESS OTHERWISE INDICATED, THE FIRST CHOICE APPLIES TO THE 2004 MASTERFORMAT AND THE SECOND CHOICE APPLIES TO THE 1995 MASTERFORMAT.

SECTION [26 26 13] [16471]

COMPUTER POWER DISTRIBUTION EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. **Scope:** Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for computer power distribution equipment as required for the complete performance of the work, and as shown on the Drawings and as herein specified.
- B. **Section Includes:** The work specified in this Section includes, but shall not be limited to, electrical characteristics and general requirements for computer power distribution equipment, hereafter referred to as the power distribution unit (PDU). The PDU shall be designed primarily for distribution of electrical power in a computer room; however, its design shall also permit its use in office, factory, and other applications as well. The PDU shall provide distribution, control, and optional monitoring of AC power, and shall properly interface the building's AC power source with sensitive electronic loads.

1.2 REFERENCES

- A. **General:** The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
- B. **Canadian Standards Association (CSA):**
 - 1. CSA C22.2 No. 950, "Information Processing and Business Equipment."
- C. **International Organization for Standardization (ISO):**
 - 1. ISO 9000, "Quality Management Systems - Fundamentals and Vocabulary."
 - 2. ISO 9001, "Quality Management Systems - Requirements."
- D. **National Electrical Manufacturers Association (NEMA):**
 - 1. NEMA AB 1, "Molded Case Circuit Breakers and Molded Case Switches."
 - 2. NEMA PB 1, "Panelboards" (copyrighted by NEMA, ANSI approved).

- E. **National Fire Protection Association (NFPA):**
 1. NFPA 70, "National Electrical Code" (copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC.
- F. **Underwriters Laboratories, Inc. (UL):**
 1. UL 60950, "Standard for Safety of Information Technology Equipment Including Electrical Business Equipment."
 2. UL/cUL 891, Standard for Dead Front Switchboards

1.3 SYSTEM DESCRIPTION

- A. **Design Requirements:** The PDU shall be sized for [400 kVA] [500 kVA]
- B. **Input Characteristics:**
 1. **Voltage:** [480] volts AC, three-phase, 3 wires plus ground
 2. **Frequency:** 60 hertz
 3. **Current:** 482 amperes (400 KVA), 602 amperes (500 KVA)
 4. **SCCR:** 65 kA at 480 V
- C. **Output Characteristics:**
 1. **Voltage:** [208 volts AC/120 volts AC, three-phase, 4 wires plus ground] [400 volts AC/230 volts AC, three-phase, 4 wires plus ground (optional on aluminum transformers)]
 2. **Frequency:** 60 hertz
 3. **Current:**
 - a. [400 kVA at 208 V]: 1110 amperes ()
 - b. [400 kVA at 400 V]: 577 amperes ()
 - c. [500 kVA at 208 V]: 1388 amperes ()
 - d. [500 kVA at 400 V]: 722 amperes ()
 4. Heat dissipation

kVA	Copper transformer 400 kVA	Aluminum transformer 400 kVA	Copper transformer 500 kVA	Aluminum transformer 500 kVA
BTU/hr	14592	16018	18450	20616

1.4 SUBMITTALS

- A. **Product Data:** Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Product data shall include, but shall not be limited to, the following:
 1. Catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
 2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product inspecting and testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of the product. Include equipment installation outline, connection diagram for external cabling, internal wiring diagram, and written instruction for installation.
- B. **Shop Drawings:** Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data, including, but not limited to, complete electrical characteristics and connection requirements. Provide detailed equipment outlines with cabinet dimensions and spacing requirements; location of conduit entry/exit paths; location of floor/seismic mounting; cabinet weights; heat rejection and air flow requirements; single-line diagram; and control and external wiring.

- C. **Wiring Diagrams:** Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.
- D. **Contract Closeout Submittals:**
 - 1. **Project Record Documents:** Submit a complete set of installation drawings showing all the information specified elsewhere in this Section.
 - 2. **Operation and Maintenance Data:** Submit operation and maintenance data to include in operation and maintenance manuals including, but not limited to, safe and correct operation of PDU functions.

1.5 QUALITY ASSURANCE

- A. **Qualifications:**
 - 1. **Manufacturer Qualifications:** Manufacturer shall be a firm engaged in the manufacture of PDU of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.
 - a. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.
 - 2. **Installer Qualifications:** Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing PDU similar in type and scope to that required for this Project.
- B. **Regulatory Requirements:** Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
 - 1. The following standards and documents apply to the specified equipment to the extent defined herein:
 - a. Underwriters Laboratories (UL 60950 and UL891)
 - b. Canadian Standards Association (CSA C22.2 No. 950)
 - c. Department of Energy (DOE)
 - d. National Electrical Manufacturers Association (NEMA AB1, NEMA PB1)
 - e. Trade Adjustment Assistance (TAA)
 - f. Office of Statewide Health Planning and Development (OSHPD)
 - g. National Electrical Code (NEC - NFPA 70)
 - h. ISO9000
 - i. Federal Communication Commission (FCC Part 15, Subpart J, Class A)
 - j. Restriction of Hazardous Substances Directive (RoHS)
- C. **Factory Testing:** Prior to shipment the manufacturer shall complete a documented test procedure to test functions of the PDU and warrant compliance with this Section. The factory test shall be performed in the presence of the Owner providing the manufacturer receives adequate prior notice. The manufacturer shall provide a copy of the test report upon request. Factory witness test is an optional service.
- D. **Source Responsibility:** Materials and parts comprising the PDU shall be new, of current manufacture, and shall not have been in prior service, except as required during factory testing. Active electronic devices shall be solid state and shall not exceed the manufacturer's recommended tolerances for temperature or current to ensure maximum reliability. Semiconductor devices shall be sealed. Relays shall be provided with dust covers. The manufacturer shall conduct inspections on incoming parts, modular assemblies, and final products.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.
- B. The customer shall store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
- C. Products shall be packaged in a manner to prevent penetration by debris and to allow safe delivery by modes of ground transportation and air transportation where specified.
- D. Prior to shipping, products shall be inspected at the factory for damage.
- E. Equipment shall be protected against extreme temperature and humidity and shall be stored in a conditioned or protected environment.

1.7 PROJECT CONDITIONS

- A. **Environmental Requirements:** Do not install the PDU until space is enclosed and weatherproof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.
 - 1. **Temperature:**
 - a. **Operating:** 14 °F (-10 °C) to 104 °F (40 °C).
 - b. **Non-Operating:** -13 °F (-25 °C) to 131 °F (55 °C).
 - 2. **Relative Humidity:**
 - a. **Operating:** 10% to 70% non-condensing.
 - b. **Non-Operating:** 10% to 90% condensing.
 - 3. **Altitude:**
 - a. **Operating:** 0 feet (0 m) below to 6600 feet (2011 m) above sea level.
 - b. **Non-Operating:** 500 feet (152 m) below to 25,000 feet (7620 m) above sea level.

1.8 WARRANTY

- A. **Special Warranty:** The Contractor shall warrant the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for period indicated below. This special warranty shall extend the one-year period of limitations contained in the General Conditions. The special warranty shall be countersigned by the Installer and the manufacturer.
 - 1. **Power Distribution Unit:** The PDU shall be covered by a full parts and labor warranty from the manufacturer for a period of 12 months from date of installation or acceptance by the Owner or 18 months from date of shipment from the manufacturer, whichever occurs first.
- B. **Additional Owner Rights:** The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.9 MAINTENANCE

- A. A complete offering of preventative and full-service maintenance contracts for the PDU shall be available from the manufacturer. Contract work shall be performed by factory trained service personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis of Design:** Product specified is "Power distribution unit (PDU)" as manufactured by APC by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.

2.2 MODES OF OPERATION

- A. **Normal Operation:** The PDU shall provide distribution, control, and monitoring (optional) of AC power, a 480-volt AC source shall be connected to the input terminals of the main input device. The main input device shall feed power to the isolation transformer, the secondary side of the transformer (at 400 V or 208 V) shall feed the main output device (optional), to then feed each of the subfeed breakers mounted on the panelboard. Load circuits shall be able to be controlled manually from distribution panelboard.

2.3 COMPONENT DESCRIPTION

- A. The PDU shall be provided with output distribution panelboard, with the following characteristics and/or features
1. **Panelboard:** NEMA PB 1, Square D "I-LINE OEM Single-row center feed Panelboard" accepting J frame and L frame circuit breakers.
 - a. **Breaker capacity:** The I-Line panelboard has 63 inches of available installation length, which allows the installation of 14 J-frame breakers (4.5 inches each) or 10 L-frame breakers (6 inches each). Only 3-pole circuit breakers can be installed. A combination between L and J frame breakers can be installed.
 - b. **Bus Rating:** 1600 amperes.
 - c. **Copper Ground Bus:** 23 (2-hole) terminals.
 - d. **Copper Neutral Bus:** Rated for 200% of nominal phase current.
 - e. **Subfeed Circuit Breakers:** J-Frame breakers (250 A 80% rated, 250 A 100% rated), L-frame breakers (400 A 80 rated, 400 A 100% rated, 600 A 80% rated).
 2. **Main Output Device:** The PDU may have one main output breaker (described below).
 - a. **Rating:** 1600 A 100% rated for 500 kVA unit, 1200 A 100% rated for 400 kVA unit. amperes.
 - b. **Interrupting Capacity:** 100 kA at 240 V, 65 kA at 480 V
 - c. **Voltage Rating:** 600 volts AC maximum.
 - d. **Model Type:** RJF36160CU33A and RJF36120CU33A
 3. **Grounding:** A main grounding busbar shall be provided and shall be effectively bonded to the unit frame. The panelboard shall have a ground bus located below the panelboard. The panelboard ground bus shall be mounted in a fashion to allow easy access.
 4. **Main Isolation:** The main isolation transformer is provided as a standard feature. The output rating of the transformer shall be the same as the continuous duty maximum full load rating of the PDU. The isolation transformer is a NEMA ST20, factory-assembled, dry type, double-shielded isolation transformer with 200% rated neutral. The transformer features NEMA TP2 efficiency compliance, Delta Wye. The isolation transformer characteristics are described below:
 - a. **Input voltage: 480 V**
 - b. **Output voltage:**
 - 1) **Aluminum option: 208 V or 400 V**
 - 2) **Copper option: 208 V**
 - c. **Impedance:** 3.4% for 400 kVA, 4% for 500 kVA
 - d. **Inrush:** Not to exceed 10x of nominal input current.
 - e. **K-Factor:** K9 for aluminum transformer, and K13 for copper transformer
 - f. **Windings:**
 - 1) **Aluminum option: 400- 500 kVA**
 - 2) **Copper option: 400-500 kVA**
 - g. **Harmonic Distortion:** less than 1%
 - h. **Efficiency:** Greater than 98% at full load, 150 °C; meets TP2 efficiency

- i. **Basic impulse level:** 10 kV
- j. **Noise Level:** 60 dB maximum
- k. **Insulation class:** 220 (R)
- l. **Ventilation:** Natural cooled
- m. **Taps:** Compensation taps are provided on the primary windings to allow field adjustment for either low or high source voltages as follows:
 - 1) FCAN = Full capacity above normal (taps): 2.5%, 5.0%
 - 2) FCBN = Full capacity below normal (taps): 2.5%, 5.0%, 7.5%, 10%
- n. **Temperature Sensors:** Two thermal switches are wound into each coil "hot spot". The switches are normally-open contacts. The switches are wired to a terminal block mounted inside the cabinet. At 180 °C, the first contact closes and causes light indicator to illuminate and an audible alarm to turn on at the status panel. At 195 °C, the second contact closes, causing the main input circuit breaker to trip. A light indicator will illuminate on the status panel and an audible alarm will sound.

2.4 SYSTEM CONTROLS AND INDICATORS

- A. **Monitoring:** The PDU shall have monitoring capability. By default, the transformer secondary output and distribution panelboard are monitored. When advanced monitoring is selected, the PDU shall be equipped with advanced multi-function meter options that shall encompass additional metering and monitoring features. Optionally, the primary of the transformer can be monitored as well.

2.5 MECHANICAL DESIGN AND VENTILATION

- A. **Cabinet:** The PDU shall be housed in a freestanding NEMA 1 cabinet with dead-front construction and a hinged lockable front door. The PDU shall accommodate either top or bottom feed cables. The system display, output circuit breakers, and Owner power and control connection points shall be accessible from the front or side of the PDU. Rear access shall not be required for normal maintenance. Circuit breakers shall be protected with dead-front panels to prevent access without a tool. Doors and outside panel color shall be white, dry epoxy finish, designed to resist scratching. The cabinet shall be secured using anchoring brackets, or bolted to the floor or floor stands by accessing the threaded holes.
- B. **Conduit Landing:** The conduit plate shall be provided for top incoming, bottom incoming, and for top and bottom outgoing cables. No knockout(s) are included.
- C. **Ventilation and Heat Rejection:** The PDU shall be natural-cooled and shall have nominal heat rejection.
- D. **Termination:** Power wiring shall be suitably terminated using UL-acceptable pressure (crimp) or screw type lug assemblies. Belleville type washers and lock washers shall be used on associated studs or bolt stacks. Control instrumentation, PC board, and interconnection wiring terminations shall conform to the UL standard.
- E. **Power Wiring:** Internal wiring shall be stranded copper with PVC, neoprene or silicon insulation with a minimum operating voltage of 600 volts RMS. Wires shall be appropriately marked UL and CSA recognized as being suitable for the application. Minimum insulation temperature rating shall be no less than 221 °F (105 °C), and, in no case, less than that required by the location/application of the wiring.
- F. **Control Wiring:** Control and instrumentation wiring used in this application shall be tinned, stranded copper with a temperature rating of at least 167 °F (75 °C). Insulation type shall be at least 125% of anticipated continuous load (three hours or longer). Voltage rating shall be no less than required per UL and NEC. In areas where either primary or secondary AC voltages are present, PC board wiring and interconnect wiring shall conform to the requirements of UL 60950 for the application and location of the wiring.

G. **Dimensions and Weights:**

1. The standard dimensions of the PDU cabinet shall be 43.0 inches (1092.2 mm) deep by 60.0 inches (1524 mm) wide by 80.0 inches (2032 mm) high. The weight shall not exceed 5200 lbs. (2358.68 kg).

2.6 METERING

A. **Power Monitoring:**

1. **Standard meters (default)**

- a. **Main output, EM3500:** This meter shall monitor for and display the PDU main output parameters. The monitor shall display the main output/load side voltage, current, kVA, kW, and frequency and other parameters defined below. (Accuracy Class 0.5S)
- b. **Output branch distribution EM4914A (MCM-2):** This meter shall monitor for and display the PDU branch distribution breakers. The monitor shall display the main output/load side voltage, current, kVA, kW, and frequency and other parameters defined below. (Accuracy Class 0.5)

- B. Measured values shall be displayed on a large format touch screen 7-inch display mounted on the front of the PDU. The meter shall also be equipped with LED alarm status indication and shall have an RS-485 serial interface operating on Modbus protocol, and Ethernet as well.

All meters are revenue grade accuracy of 1% or better, with communication via Modbus TCP/IP, Ethernet, and SNMP (V1 and V3) A BACnet communication option is sold separately.

1. The monitor shall display the following values and alarm conditions:

a. **Data Output:**

- 1) kWh energy consumption.
- 2) kW real power.
- 3) kVA apparent power.
- 4) Power factor total.
- 5) Voltage, L-L, average of three phases.
- 6) Voltage, L-N, average of three phases.
- 7) Current, average of three phases.
- 8) kW real power, phase A, B, C.
- 9) Power factor, phase A, B, C.
- 10) Line-to-line voltage, phase A-B.
- 11) Line-to-line voltage, phase B-C.
- 12) Line-to-line voltage, phase A-C.
- 13) Line-to-neutral voltage, phase A-N.
- 14) Line-to-neutral voltage, phase B-N.
- 15) Line-to-neutral voltage, phase C-N.
- 16) Current, phase A, B, C.
- 17) kW average.
- 18) kW minimum.
- 19) Frequency (measured from phase A).

b. **Alarms:**

- 1) Overvoltage.
- 2) Undervoltage.
- 3) Overcurrent.
- 4) Undercurrent.
- 5) Over kVA.
- 6) Under kVA.
- 7) Phase loss A.
- 8) Phase loss B.
- 9) Phase loss C.
- 10) Breaker trip indicator for all subfeed breakers

2. **Controls and Communications:** The Owner shall be able to control and communicate with the PDU via the following interfaces:

- a. Emergency power off (EPO as standard and REPO sold separately) button that when activated shall trip the AC input circuit breaker with shunt trip.
- b. Audible alarm test/mute pushbutton.

- c. Dry contact Form C relay located on the MCM monitor and activated by any condition listed elsewhere in this Section.
- d. RS-485 serial communications interface.
- e. Ethernet port

2.7 OPTIONAL ACCESSORIES

- A. **Shunt Trip Main Breaker:** The PDU main breaker may be equipped with a 120-volt UV shunt trip which, when activated, shall cause the breaker to open.
- B. **Subfeed Circuit Breakers:** Molded case breaker options:
 - 1. NEMA AB 1
 - 2. J-Frame LSI 250 A 80% rated 25 kA at 240 V
 - 3. J-Frame LSI 250 A 80% rated 65 kA at 240 V
 - 4. J-Frame LSI 250 A 100% rated 25 kA at 240 V
 - 5. J-Frame LSI 250 A 100% rated 65 kA at 240 V
 - 6. L-Frame LSI 400 A 80% rated 25 kA at 240 V
 - 7. L-Frame LSI 400 A 80% rated 65 kA at 240 V
 - 8. L-Frame LSI 400 A 100% rated 25 kA at 240 V
 - 9. L-Frame LSI 400 A 100% rated 65 kA at 240 V
 - 10. L-Frame LSI 600 A 80% rated 25 kA at 240 V
 - 11. L-Frame LSI 600 A 80% rated 65 kA at 240 V
- C. **Panelboard Isolated Ground Bus:** An additional isolated ground busbar may be provided that shall be dedicated for termination of isolated ground. The isolated ground bus shall be bonded to the main grounding busbar.
- D. **StruxureWare Data Center Expert:** A centralized infrastructure management platform hereafter referred to as Data Center Expert shall be available for purposes of complete system monitoring and management of all components outlined in this specification used as a single solution for small IT or part of the StruxureWare software stack providing data to systems such as Data Center Operation.
 - 1. Monitoring - Data Center Expert can monitor a PDU through a network of Cat 5 cable and a 24-port hub, supplied by the PDU manufacturer. This 24-port hub shall relay information to Data Center Expert, which in turn shall allow access to this information via the user's public network via a single IP address.
 - 2. Monitored Values: Data Center Expert shall be capable of monitoring alarms, general status parameters, voltage and current of the PDU.
 - 3. Thresholds: For individualized customer needs, Data Center Expert shall allow for user configurable thresholds for alarm notification. With this feature, Data Center Expert can notify clients of reaching thresholds for PDU capacity, or branch circuit breaker capacity. Other custom programmable alarm points for non-Schneider Electric products shall also be available via dry contact input signal.
 - 4. Public Network Monitoring: Data Center Expert shall also be capable of monitoring other Schneider Electric devices that are connected to the client's public network
- E. **Optional meters.**
 - 1. **Main input, EM3500:** EM3500 is a versatile meter for energy cost and basic network management data monitoring. This meter shall monitor for and display the PDU main input parameters. The monitor shall display the main output/load side voltage, current, kVA, kW, and frequency and other parameters defined in section 2.6 "Metering". (Accuracy Class 0.5S).
 - 2. **Main input, output or both advanced PM5563:** PM5563 is an advanced meter option for monitoring input power quality and higher accuracy, in addition to basic network management data. This meter shall monitor for and display the PDU main input parameters. The monitor

shall display the main output/load side voltage, current, kVA, kW, and frequency and other parameters defined in section 2.6 "Metering". Power quality parameters are also monitored from the meter output data. (THD available, Accuracy Class 0.2S).

PART 3 – EXECUTION

3.1 EXAMINATION

- A. **Verification of Conditions:** Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
 - 1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

- A. Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.

3.3 FIELD QUALITY CONTROL

- A. **Field Service Representative Qualifications:** The manufacturer shall employ a 7 x 24 nationwide (international where applicable) field service organization with rapid access to all regions of the nation. The responding service professionals shall be factory-trained engineers with an accredited and proven competence to service PDU equipment.

3.4 DEMONSTRATION

- A. Provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.
 - 1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 - 2. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 3. Review data in operation and maintenance manuals with the Owner's personnel.

END OF SECTION