

## SECTION 22 34 36.23 - SAMPLE SPECIFICATION FOR RBI TORUS MODULATING STAINLESS STEEL WATER HEATER

**PART 1 - GENERAL**

## 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

## 1.2 SUMMARY

- A. This Section includes gas-fired, condensing stainless steel watertube water heaters for heating hot water.
- B. Related Sections include the following:
  - 1. Division 22 Section "Breechings, Chimneys, and Stacks" for connections to breechings, chimneys, and stacks.
  - 2. Division 22 Section "Feedwater Equipment" for connections to condensate and feed water system.
  - 3. Division 22 Sections for control wiring for automatic temperature control.

## 1.3 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, and method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturers installed and field installed wiring.
- C. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.
- D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- E. Maintenance Data: Include in the maintenance manuals specified in Division 1. Include parts list, maintenance guide, and wiring diagrams for each water heater.

## 1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
  - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. ASME Compliance: Water heaters shall bear ASME "HLW" stamp and be National Board listed.
- C. FM Compliance: Control devices and control sequences according to requirements of FM.
- D. Comply with NFPA 70 for electrical components and installation.
- E. IRI Compliance: Control devices and control sequences according to requirements of IRI (GE GAP).
- F. CSD-1
- G. SCAQMD Rule 1146.2 for low NOx equipment

## 1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."

## 1.6 WARRANTY

- A. General Warranty: The special warranty specified in this Article 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. Installing contractor shall provide one year of warranty parts and labor.

# RBI MASTERSPEC

- B. Special Warranty: Submit a written warranty, executed by the contractor for the heat exchanger.
  - 1. Warranty Period: The heat exchanger assembly shall carry a five (5) year warranty with an additional twenty-one (21) year thermal shock warranty on heat exchanger.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Manufacturers: Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum five (5) years experience. Subject to compliance with requirements, manufacturers offering water heaters that may be incorporated into the Work include, but are not limited to, the following:
- B. Design: Water heaters shall be CSA design certified as a condensing water heater. Water heaters shall be designed for a minimum of (10:1 - 400, 500, 650, 800, 1000, 1250, 1500, 2000, 3000; 9:1 - 350, 4000; 8:1 - 300, 2500) Natural Gas, (8:1 - 300, 350, 400, 500, 650, 800, 1000, 1250, 1500, 2000, 2500, 3000, 4000) propane, continuous turn down with constant CO<sub>2</sub> over the turndown range. The water heater shall operate with natural gas or propane and have a CSA International certified input rating as noted on the drawings, and a thermal efficiency rating up to 99% at minimum input. The water heater shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. The water heater will automatically adjust input for altitude and temperature induced changes in air density. The water heater will use a proven direct spark ignition (DSI) system. The water heater shall use a UL approved flame safeguard ignition control system using flame rod detection. The design shall provide for silent burner ignition and operation. A corrosion resistant condensate drain designed to prevent pooling and accessible condensate trap shall be provided. In some jurisdictions, a means of neutralizing the condensate pH levels may be required. Water heater shall be able to vent a horizontal distance of 100 equivalent feet, 30.5m (300-1000), and 160 equivalent feet, 48.7m (1250-4000) with a vent diameter equivalent to the combustion chamber outlet diameter.
- C. Service Access: The water heaters shall be provided with access covers for easily accessing all serviceable components. The water heaters shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All accesses must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.
- D. Indicating lights: Each water heater shall include a diagnostic control panel with a full Digital Text LCD Touch Screen Display indicating the condition of all interlocks and the BTUH input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.
- E. Manufacturers: RBI (a Mestek Company) is the basis of design. Listed acceptable manufacturers shall be subject to compliance with requirements. Provide water heaters by one of the following:
  - 1. Lochinvar (Armor Water Heater)
  - 2. Thermal Solutions (AMPW)
  - 3. HTP (Elite XL-VWH Model)

### 2.2 COMPONENTS

- A. Combustion Chamber: The combustion chamber shall be constructed of 316L stainless steel and fully surround the burner for maximum efficiency.
- B. Heat Exchanger: The primary heat exchanger shall be of a helically wound, multi-pass design and shall completely encircle the combustion chamber for maximum efficiency.
- C. The heat exchanger shall incorporate a slide out door for full access of burner and tubes.
- D. The water heater(s) shall be ASME inspected and stamped and National Board registered for 160 PSIG maximum allowable working pressure and 210°F maximum allowable temperature, complete with a Manufacturer's Data Report.
- E. The flue connection, gas connection, water connections and condensate drain shall be located on the rear of the unit.
- F. Jackets: Painted Carbon Steel.
- G. Gas Burner: The combustion chamber shall be of the sealed combustion type employing the "Bluejet" burner, mounted in a horizontal orientation.
- H. The burner shall be a premix design and constructed of high stainless steel grade and capable of firing at 100% of rated input when supplied with three-inch (4.0") WC of inlet natural gas pressure, so as to maintain service under heavy demand conditions; no exceptions.

# RBI MASTERSPEC

- I. The burner shall use a combustion air blower to precisely control the fuel/air mixture for maximum efficiency throughout the entire range of modulation. The combustion air blower shall operate for a pre-purge period before burner ignition and a post-purge period after burner operation to clear the combustion chamber.
- J. Ignition components: The water heater(s) shall be equipped with a 100 percent safety shutdown.
- K. The ignition shall be proven Direct Spark Ignition (DSI) type with full flame rectification by remote sensing separately from the ignition source. Ceramic hot surface ignition will not be accepted.
- L. An external viewing port shall be provided, permitting visual observation of burner operation accepted. The ignition hardware shall consist of Alumina ceramic insulated ignition electrodes and Rauschert XR flame rod sensing permanently arranged to ensure proper ignition electrode alignment.
- M. Rated Capacity: The water heater shall be capable of operating at rated capacity with gas pressures as low as 4" W.C. at the inlet to the burner gas valve.
- N. The burner and gas train shall be provided with the following trim and features:
  - 1. The burner shall be a premix design and constructed of stainless steel "Bluejet".
  - 2. The burner shall be capable of and provide variable modulating firing rates.
  - 3. The burner shall be capable of operating with repeatable CO<sub>2</sub> at both low fire and high fire modulating firing rates.
  - 4. The burner shall be capable of operating without exceeding 20ppm of NO<sub>x</sub>.
  - 5. The water heater shall be supplied with a zero governor gas valve coupled with a variable speed blower system, to precisely control the fuel/air mixture for maximum combustion efficiency.
  - 6. Burner Ignition: Direct spark (DSI) type with full flame rectification by remote sensing separately from ignition source.
  - 7. Flue Gas Collector: Enclosed combustion chamber with integral combustion air blower and single venting connection.
  - 8. Gas Train: Manual ball type gas valves (2), main gas valve, and manual leak test valve. All components to be factory mounted and CSD-1 compliant.
  - 9. Safety Devices: Low gas pressure switch, air flow switch, and blocked flue detection switch, low water cutoff (manual reset), high temperature manual reset. All safeties to be factory mounted.
  - 10. Optional Dual Fuel Capacity: if/when scheduled the Water Heater shall include a gas train and combustion system capable of dual fuel operation. The dual fuel Water Heater shall be able to operate on both natural gas and propane. The Water Heater efficiency and turndown shall remain constant regardless of fuel selection. The dual fuel combustion system shall incorporate individual natural gas and propane gas trains, which will meet all applicable national and local codes and standards. The dual fuel system shall have a fuel selector switch for automatic fuel changeover. There shall be no manual fuel changeover devices incorporated with the dual fuel system. The switching mechanism shall be designed so there is no possibility of both fuels flowing simultaneously. The Water Heater shall be commissioned and calibrated to run on both fuel sources at start-up. No additional re-calibration shall be required when switching fuel systems until the next annual service date for the Water Heater.

## 2.3 WATER HEATER TRIM

- A. Controls: The water heater control package shall be a HeatNet or equivalent, integrated water heater management system. The control system must be integral to each water heater, creating a control network that eliminates the need for a "wall mount" stand-alone water heater system control. Additional stand-alone control panels, independent of a Building Management System (BMS), shall not be allowed to operate the water heater network.

The HeatNet control shall be capable of operating in the following ways:

- 1. As a stand-alone water heater control system using the HeatNet protocol, with one "Master" and multiple "Member" units.
- 2. As a water heater network, enabled by a Building Management System (BMS), using the HeatNet protocol, with one "Master" and multiple "Member" units.
- 3. As "Member" water heaters to a Building Management System (BMS) with multiple input control methods.
- 4. Failsafe mode – When a Building Automation System is controlling set point, if communications are lost, the water heater/ system will run off the Local set point.
- 5. Adaptive Modulation – Lowers the modulation rate of all currently operating water heaters before a newly added water heater enters operation.
- 6. Priority Firing – Allows mixing of condensing, non-condensing base load and/or other combination of (2) functional water heater types utilizing (2) priority levels.

# RBI MASTERSPEC

7. Available priority start/stop qualifiers shall be done using any combination of: A) Modulation Percentage B) Outdoor Air Temperature or C) Return Water Temperature.
8. Base Loading – Provides the ability to control (1) base load water heater with enable/disable and 4-20mA modulating signal (if required).

MASTER: A water heater becomes a Master when a resistance type 10K sensor is connected to the J10 “SYS/ DHW HEADER” terminals. **The sensor shall be auto-detected.** The Master senses and controls the header/loop temperature utilizing a system set point. It uses any water heaters it finds “HeatNet Members” or those defined in the control setup menus to accomplish this. The “Master” shall also have the option of monitoring Outside Air Temperature “OA” to provide full outdoor air reset functionality. **Only one master shall be allowed in the water heater network.**

When operating as a “Master”, the HeatNet control provides a stand-alone method using a PID algorithm to regulate water temperature. The algorithm allows a single water heater “Master” or multiple “Master + Member” water heaters in a network of up to 16 total water heaters. The control algorithm is based upon a control band, at the center of which is the set point. While below the control band, water heaters are staged on and modulated up until the control band is entered. Once in the control band, modulation is used to maintain set point. Optimized system efficiency is always accomplished by setting the Modulation Maximum “Mod-Max” setting to exploit each water heater in the network’s inverse efficiency curve. The control shall operate so that the maximum number of water heaters required, operate at their lowest inputs until all water heaters are firing. Once all water heaters are firing, the modulation clamp is removed and all water heaters are allowed to fire above this clamped percentage up to 100%. This “water heater efficiency” clamp is defaulted to 70% and thus limits all the water heaters individual outputs to 70% until the last water heater fires. **The 70% default must be field adjustable for varying operating conditions.** All water heaters modulate up and down together always at the same modulation rate. Water heaters are shut down only when the top of the band is breached, or before the top of the band, if the control anticipates that there is a light load. Timers shall also be included in each control in the network to prevent any water heater from short cycling.

MEMBER: Additional water heaters in the network always default to the role of member. The lack of sensors connected to the J10 terminals “SYS/DHW Header” on each additional water heater shall ensure this.

Each “Member” shall sense its supply outlet water temperature and modulate based on signals from a Building Management System (BMS) or “Master” water heater. When operating as a member, starting, stopping, and firing rate shall also be controlled by the “BMS” or “Master” water heater.

When using the HeatNet protocol, the system set point shall be sent from the “Master”, along with the modulation value to control firing rate. It also receives its command to start or stop over the HeatNet cable. Each “Member” will continuously monitor its supply outlet temperature against its operating limit. If the supply temperature approaches the operating limit temperature (adjustable), the water heaters input control rate is limited and its modulation value decreases to minimize short cycling. If the operating limit is exceeded, the water heater shall shut off.

Each HeatNet control in the water heater network shall have the following standard features:

1. Digital Communications Control.
  - A. Water heater to Water heater: HeatNet
  - B. Building Management System (BMS): MODBUS standard protocol. (BACnet, LONWORKS and N2 optional protocols)
2. Analog 4:20 and 0-10vdc also supported.
3. Distributed control using HeatNet protocol for up to 16 total water heaters.
4. English text display.
5. Interlock, Event, and System logging with a time stamp.
6. Advanced PID algorithm optimized for TORUS water heaters.
7. Four dedicated temperature sensor inputs for: Outside Air Temperature, Supply (Outlet Temperature, Return Temperature (Inlet)), and Header Temperature.
8. Automatically detects the optional temperature sensors on start up.
9. Touch Screen Display.
10. (8) Dedicated 24vac interlock monitors and 8 dedicated 120vac system monitors used for diagnostics and providing feedback of faults and system status.
11. Multiple water heater pump or motorized water heater valve control modes.
12. Combustion Air Damper control with proof time.
13. Optional USB/RS485 network plug-in to allow firmware updates or custom configurations.
14. Optional BACnet, LONWORKS and N2 interface.

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15. Alarm contacts.
  16. Runtime hours.
  17. Outdoor Air Reset with programmable ratio.
  18. Time of Day clock to provide up to four (4) night setback temperatures.
  19. Failsafe mode when a Building Management System (BMS) is controlling set point. If communications are lost, the water heater/ system shall run off the Local Set point.
  20. Support for domestic hot water (DHW) using a 10k sensor or a dry contact input from a tank thermostat and a domestic hot water relay (pump/valve).
  21. Allows for selection of any water heater in the network to act as Lead Water heater.
  22. Adaptive Modulation feature in which the Master water heater adjusts the system modulation rate to a lower value when a new water heater in the network is started to compensate for the added BTU's to the system. Once the newly added water heater fires and the adjustable time expire, the Master resumes control of the system modulation to maintain set-point temperature.
  23. Priority firing – Allows mixing of condensing and non-condensing, base load and/or other combination of (2) functional water heater types utilizing (2) priority levels.
  24. Available priority start/stop qualifiers shall be done using any combination of: A) modulation percentage, B) outdoor air temperature, (or) C) return water temperature.
  25. Base Loading – Provides the ability to control (1) base load water heater with enable/disable and 4-20mA modulating signal (if required).
  26. Water heater(s) shall be equipped with an integrated web based monitoring system.
    - A. Monitoring system shall provide an email or SMS text message notification upon detecting an out of tolerance condition.
    - B. The integrated monitoring system shall provide a web portal with performance dashboard displaying key data points for the system and each water heater in the system.
    - C. The web portal shall provide the following capabilities;
      - Detailed status of data points and system set-points
      - Water heater and System runtime and cycle count
      - Intelligent diagnostics and troubleshooting guide
      - Provide original factory test data including as built bill of materials
      - The ability to enter field service records with file upload capabilities
      - The ability to view time stamped history of data points and settings
      - The ability to view detailed event log entries
      - Video tutorials explaining each section of the web portal
    - D. The monitoring system shall have the capability of connecting directly to a 10/100mbps TCP/IP network Optionally when a facility network connection is not available the system shall be capable of utilizing wireless cellular network
    - E. The monitoring system shall utilize a non-public proprietary data encryption algorithm
    - F. Secure data transmission shall be directly to the cloud from HeatNet enabled system(s) without third party integration
- B. Safety Temperature and pressure relief Valve: ASME rated, factory set to protect water heater and piping as per schedule/ drawings. 160 psi maximum allowable working pressure.
  - C. Gauge: Combination water pressure and temperature shipped factory installed. LCD outlet temperature readout to be an integral part of the front water heater control panel display to allow for consistent easy monitoring of temperatures factory mounted and wired.
  - D. Flow Sensor: Water heater shall have the ability to communicate with a digital flow sensing device integral to the water heater control system, mounted in a by-pass and mapped to indicate the water heater flow in (gpm), the flow sensor utilizes vortex technology which is then converted to an electronic signal sent directly to the Water heater Control System for real time flow annunciation. The set-point is fully adjustable throughout the water heater model operating range.
  - E. Burner Controls: Water heater shall be provided with a Fenwal series flame safe guard with flame rod rectification.
  - F. High Limit: Temperature control with manual reset limits water heater water temperature in series with the operating control. High Limit shall be factory mounted and sense the outlet temperature of the water heater through a dry well.
  - G. PROVIDE THE FOLLOWING STANDARD TRIM:
    1. Low Air Pressure Switch
    2. Blocked Flue Switch

# RBI MASTERSPEC

3. Modulation Control
4. Temperature/Pressure Gauge
5. Manual Reset High Limit (CSD-1 Factory Mounted and Wired)
6. Low Gas Pressure Switch (WW2500, WW4000)
7. Low Water Cutoff with Manual Reset (CSD-1 Factory mounted and wired)
8. Supply Outlet Temperature Display
9. Full Digital Text LCD Touch Screen Display for all Water heater Series of Operation and Failures
10. Air Inlet Filter
11. Combustion Air Fan with Safety Interlock
12. Condensate Drain
13. High Gas Pressure Switch (WW2500, WW4000)
14. Flow Switch Mounted & Wired
15. Temperature and pressure relief Valve

## H. PROVIDE THE FOLLOWING JOB SPECIFIC TRIM AND FEATURES:

1. Low Gas Pressure Switch
2. High Gas Pressure Switch
3. Valve Proving Switch
4. Digital Flow Sensor
5. Isolation Valve Wiring
6. Pump Starter (Strongly recommended on water heater applications)
7. 120V 1PH (WW1250 – WW1500)
8. 208/220V 1PH (WW 2000)
9. 208-230V 3PH (WW 2000-WW4000)
10. 460-600V 3PH (WW 2000-WW4000)
11. PVC Vent Option (WW1250-4000)
12. CPVC Vent Option (WW 1250-4000)
13. PP Vent Option (WW300-WW2000 DuraVent (Canada ONLY)) (WW300-WW4000 Centrotherm)

## 2.4 MOTORS

- A. Refer to Division 15 Section "Motors" for factory installed motors.
- B. Water heater Blower Motor: The Blower shall be a variable speed blower.

## 2.5 SOURCE QUALITY CONTROL

- A. Test and inspect water heaters according to the ASME Water heater and Pressure Vessel Code, Section IV. Water heaters shall be test fired in the factory with a report attached permanently to the exterior cabinet of the water heater for field reference.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine area to receive water heater for compliance with requirements for installation tolerances and other conditions affecting water heater performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

# RBI MASTERSPEC

## 3.2 INSTALLATION

- A. Install water heaters level and plumb, according to manufacturer's written instructions and referenced standards.
- B. Install gas fired water heaters according to NFPA 54.
- C. Support water heaters on a minimum 4 inches (100 mm) thick concrete base, 4 inches (100 mm) larger on each side than base of unit.
- D. Install electrical devices furnished with water heater, but not specified to be factory mounted.

## 3.3 CONNECTIONS

- A. Connect gas piping full size, to water heater gas train inlet with union.
- B. Connect hot water piping to the inlet and outlet water heater connections with shutoff valve and union or flange at each connection.
- C. Install piping from safety temperature and pressure relief valves to nearest floor drain.
- D. Connect breeching to water heater outlet, full size of outlet. The water heater shall operate under positive (Category IV) or negative (Category II) stack pressure per the requirements of the Installation and Operation manual. Exhaust material must be a Stainless steel, PVC, CPVC or PP flue designed for condensing appliances per the requirements listed in the Installation and Operation manual.
- E. Electrical: Comply with applicable requirements in Division 16 Sections.
- F. Ground equipment.
  - 1. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

## 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory authorized service representative to supervise the field assembly of components and installation of water heaters, including piping and electrical connections. Report results in writing.
  - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Water heater shall be commissioned by factory authorized technician. Contact local representative for factory authorized technician information.
- B. Manufacturer's representative shall supply a factory authorized service technician to start up the water heaters.

## 3.5 CLEANING

- A. Flush and clean water heaters on completion of installation, according to manufacturer's written instructions.
- B. After completing water heater installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions with manufacturer's stainless steel polish.

## 3.6 COMMISSIONING

- A. Engage a factory authorized service representative to provide startup service. Startup to be performed only after complete water heater room operation is field verified to offer a substantial load, and complete system circulation. One-year warranty shall be handled by factory authorized tech.
- B. Verify that installation is as indicated and specified.
  - 1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections. Do not proceed with water heater startup until wiring installation is acceptable to equipment Installer.
- C. Complete manufacturer's installation and startup checklist and verify the following:
  - 1. Water heater is level on concrete base.
  - 2. Flue and chimney are installed without visible damage.
  - 3. No damage is visible to water heater jacket, refractory, or combustion chamber.
  - 4. Pressure reducing valves are checked for correct operation and specified temperature and pressure relief pressure. Adjust as required.
  - 5. Clearances have been provided and piping is flanged for easy removal and servicing.

# RBI MASTERSPEC

6. Heating circuit pipes have been connected to correct ports.
  7. Labels are clearly visible.
  8. Water heater, burner, and flue are clean and free of construction debris.
  9. Pressure and temperature gauges are installed.
  10. Control installations are completed.
- D. Ensure pumps operate properly.
- E. Check operation of gas pressure regulator device on gas train, including venting.
- F. Check that fluid level, flow sensor, and high temperature interlocks are in place.
- G. Start pumps and water heaters, and adjust burners to maximum operating efficiency.
1. Fill out startup checklist and attach copy with Contractor Startup Report.
  2. Check and record performance of factory provided Water Heater protection devices and firing sequences.
  3. Check and record performance of Water Heater fluid level, flow switch, and high temperature interlocks.
  4. Run-in water heater as recommended or required by manufacturer.
- H. Perform the following tests for maximum and minimum firing rates for modulating burner. Adjust water heater combustion efficiency at maximum and minimum modulation rates. Perform combustion flue gas test at minimum and maximum modulation rate. Measure and record the following:
1. Differential pressure across air / gas orifice.
  2. Combustion air temperature at inlet to burner.
  3. Flue gas temperature at water heater discharge.
  4. Flue gas carbon dioxide, oxygen, and carbon monoxide concentration.
  5. Flue gas NOx emissions where applicable.
  6. Natural flue draft.
- I. Measure and record temperature rise through each water heater.
- 3.7 DEMONSTRATION
- A. Engage a factory authorized service representative to train Owner's maintenance personnel as specified below:
1. Operate water heater, including accessories and controls, to demonstrate compliance with requirements.
  2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
  3. Review data in the maintenance manuals. Refer to Division 1 Section "Contract Closeout."
  4. Review data in the maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
  5. Schedule training with Owner with at least 7 days advance notice.

END OF SECTION 23 52 16