AERCO
A WATTS Brand

Installation, Startup, Operation & Maintenance Manual

Benchmark® E Boilers with Edge® [X] Controller

Electric Boilers

Models 216 through 684

Other documents for this product include:

OMM-0170 Edge [X] Controller for BMK-E
TAG-0110 Boiler Application Guide
TAG-0109 BMK-E ELECTRICAL POWER GUIDE

ASME H

Heating and Hot Water Solutions

OMM-0169_A • DRAFT

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IMPORTANT

Read this Manual BEFORE using this equipment. Failure to read and follow all safety and use information can result in death, serious personal injury, property damage, or damage to the equipment.

Keep this Manual for future reference.

CONTENTS

FOREWORD

The AERCO Benchmark E (BMK E) 216 through 684 electric boilers represent a true industry advance that meets the needs of today's energy and environmental concerns. Designed for application in any closed loop hydronic system, the Benchmark E's modulating capability relates energy input directly to fluctuating system loads. These BMK E models provide extremely high efficiency operation and are ideally suited for modern low temperature, as well as conventional heating systems.

IMPORTANT!

Unless otherwise specified, all descriptions in this document apply to the Benchmark E Series of boiler.

The Benchmark E models operate within the input and output ranges listed below.

Benchmark E Boiler Input Ranges

MODEL	Without SSR		With SSR	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
BMK216	36 kW (123 MBH)	216 kW (737 MBH)	3.6 kW (12 MBH)	216 kW (737 MBH)
BMK360	36 kW (123 MBH)	360 kW (1228 MBH)	3.6 kW (12 MBH)	360 kW (1228 MBH)
BMK432	36 kW (123 MBH)	432 kW (1474 MBH)	3.6 kW (12 MBH)	432 kW (1474 MBH)
BMK576	36 kW (123 MBH)	576 kW (1965 MBH)	3.6 kW (12 MBH)	576 kW (1965 MBH)
BMK684	36 kW (123 MBH)	684 kW (2334 MBH)	3.6 kW (12 MBH)	684 kW (2334 MBH)

The Benchmark E's advanced electronics are available in several selectable modes of operation offering the most efficient operating methods and energy management system integration.

SECTION 1: SAFETY PRECAUTIONS

1.1 Warnings & Cautions

Installers and operating personnel MUST, at all times, observe all safety regulations. The following warnings and cautions are general and must be given the same attention as specific precautions included in these instructions. In addition to all the requirements included in this AERCO Instruction Manual, the installation of units MUST conform with local building codes, or, in the absence of local codes, National Electrical Code (NEC) Code Publication No. NFPA-70 for resistive boilers. In Canada, the installation must comply with the latest edition of the Canadian Electrical Code, C22.1 and any applicable provincial regulations, and applicable Provincial regulations for the class; which should be carefully followed in all cases. Authorities having jurisdiction should be consulted before installations are made.

IMPORTANT!

This Manual is an integral part of the product and must be maintained in legible condition. It must be given to the user by the installer and kept in a safe place for future reference.

⚠ WARNING!

- Fluids under pressure may cause injury or damage when released. Shut off all incoming and outgoing water shutoff valves. Carefully decrease all trapped pressures to zero before performing maintenance.
- Before performing any maintenance on the unit, shut off all electrical inputs to the unit.
- Electrical voltages up to 208, 240, 480 or 600 VAC (BMK E 216 - 684) and 24 volts AC and DC may be used in this equipment. The electrical cabinet must be closed at all times except during maintenance and servicing.
- A disconnect switch must be installed on the electrical supply line of the unit. The switch must be installed in an easily accessible position to quickly and safely disconnect electrical service. Do not affix switch to unit sheet metal enclosures.

CAUTION!

DO NOT use this boiler if any part has been under water. Call a qualified technician to inspect and replace any part that has been under water.

1.2 Emergency Shutdown

If overheating occurs or the electric supply fails to shut off, disconnect electrical power using the disconnect switch located external to the unit.

NOTE: Installer must identify and indicate location of disconnect switch to operating personnel.

An emergency shutdown procedure addressing the following should be implemented at the site:

- For automatically operated unattended boilers located in a boiler room, provide a manually operated remote shutdown switch or circuit breaker located just inside or outside each boiler room door. Design the system so activation of the emergency shutdown switch or circuit breaker will immediately shut off the unit(s).
- For automatically operated unattended boilers in a location other than a boiler room, provide a manually operated remote shutdown switch or circuit breaker marked for easy identification at a location readily accessible in the event of boiler mis-operation.
- Design the system so activation of the emergency shutdown switch or circuit breaker will immediately shut off the electrical power supply to the boiler.
- For boilers monitored and/or operated from a continuously occupied control room, provide an emergency shutdown switch in the control room that is hard-wired to immediately shut off the unit upon activation.

1.3 Prolonged Shutdown

If there is an emergency, turn off the electrical power supply to the AERCO boiler. The installer must identify the emergency shut-off device.

If the unit is being shut down for an extended period of time, such as a year or more, complete the instructions in Section 7.8 *Shutting Boiler Down For Extended Period*.

When returning a unit to service after a prolonged shutdown, it is recommended that the instructions in Section 4: *Initial Startup* and Section 5: *Safety Device Testing* be performed to verify that all system-operating parameters are correct.

SECTION 2: INSTALLATION

2.1 Receiving the Unit

Each Benchmark Boiler System is shipped as a single crated unit. The shipping weight for these BMK models is approximately as follows:

- **BMK E 216 - 684:** 1,700 lbs. (771 kg)

The unit must be moved with the proper rigging equipment for safety and to avoid equipment damage. The unit should be completely inspected for evidence of shipping damage and shipment completeness at the time of receipt from the carrier and before the bill of lading is signed.

CAUTION!

While in shipping container, unit must be moved by pallet jack or forklift from the front only.

NOTE: AERCO is not responsible for lost or damaged freight. Each unit has A Tip-N-Tell indicator on the outside of the crate, which indicates if the unit has been turned on its side during shipment. If the Tip-N-Tell indicator is tripped, do not sign for the shipment. Note the information on the carrier's paperwork and request a freight claim and inspection by a claims adjuster before proceeding. Any other visual damage to the packaging materials should also be made clear to the delivering carrier.

2.2 Unpacking

Carefully unpack the unit taking care not to damage the enclosure. After unpacking, make a close inspection of the unit to ensure that there is no evidence of damage not indicated by the Tip-N-Tell indicator. The freight carrier should be notified immediately if any damage is detected.

The following accessories come standard with each unit and are either packed separately within the unit's shipping container or are factory installed on the unit:

- Pressure/Temperature Gauge
- ASME Pressure Relief Valve

When optional accessories are ordered, they may be packed within the unit's shipping container, factory installed on the unit, or packed and shipped in a separate container. Any standard or optional accessories shipped loose should be identified and stored in a safe place until ready for installation or use.

2.3 Codes

The equipment must be installed in accordance with the local installation regulations. Authorities having jurisdiction must be consulted before installation is made. In the absence of such requirements, the installation shall be in accordance with the instructions in this manual, unit markings, and supplemental instructions. Installation must also comply with the latest edition of the National Electrical Code, NFPA-70. In Canada, the installation must comply with the latest edition of the Canadian Electrical Code, C22.1 and any applicable provincial regulations.

2.4 Site Preparation

⚠ WARNING!

As with any electrical product, care should be taken to guard against the potential risk of fire, electric shock, and injury to persons.

Install the unit in a clean, dry area. The unit must be installed on a level concrete "housekeeping" pad.

Ensure that the site selected for installation of the Benchmark Boiler includes access to AC Input Power, as specified in the *Benchmark E Electrical Power Design Guide,* TAG-0109.

2.4.1 Installation Clearances

All Benchmark E models have the same width, heigh, and depth. The appliance must not be installed on a combustible floor. The minimum clearance to combustible surfaces is 0" on all sides and top. The recommended clearances for service as shown in Figure 2-1 and listed below. However, if Local Building Codes require additional clearances, these codes shall supersede AERCO's requirements.

BMK E 216 – 684 recommended clearances:

Front: 36 inches (91 cm) **Sides:** 24 inches (61 cm)

Rear: 24 inches (61 cm) **Top:** 18 inches (45.7 cm)

All water piping and electrical conduit or cable must be arranged so that they do not interfere with the removal of any panels or inhibit service or maintenance of the unit.

NOTE: There must be at least 6" of clearance behind the cooling fans at the rear of the unit.

In multiple unit installations, it is important to plan the position of each unit in advance. Sufficient space for piping connections and future service/maintenance requirements must also be taken into consideration. All piping must include ample provisions for expansion**.**

NOTE: Benchmark E units may be installed with 2" side clearances in pairs only (perimeter clearances still apply). At least 2" side clearance is required as to not block the air inlets on the side of the unit. See drawings in *Appendix A: Dimensions and Clearance Drawings*.

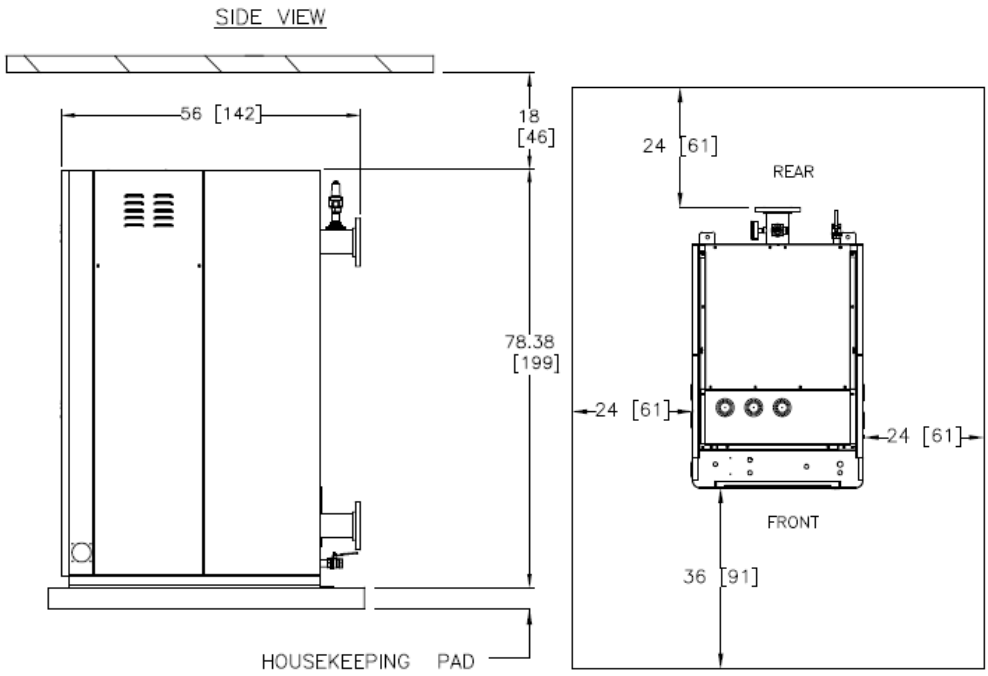


Figure 2-1: BMK E 216-684 Recommended Clearances

⚠ WARNING!

Keep area clear and free from all combustible materials and flammable vapors or liquids.

2.4.2 Setting The Unit

If anchoring the unit, refer to Figure 2-2 for anchor locations.

- All holes are flush with the bottom surface of the frame.
- All dimensions shown are in inches.

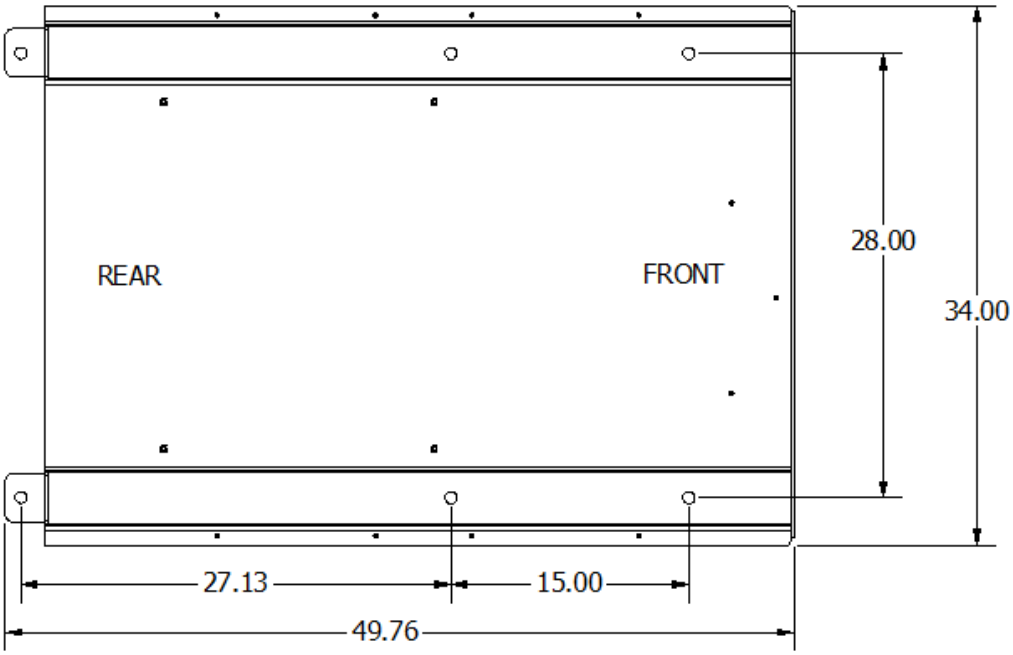


Figure 2-2: BMK E 216-684 Anchor Bolt Locations

2.5 Lifting Provisions

⚠ WARNING!

Use industry standard safe rigging methods when lifting or moving. Failure to follow these instructions could result in property damage, serious injury, or death.

Three lifting lugs are provided at the top of the pressure vessel as shown in Figure 2-4. Remove the top panel from the unit to provide access to the lifting lugs. Remove the four (4) nuts securing the unit to carriage bolts on the shipping skid. These nuts are located at the front and rear anchor bolt locations shown in Figure 2-2. Lift the unit off the shipping skid and position it on the housekeeping concrete pad (required) in the desired location.

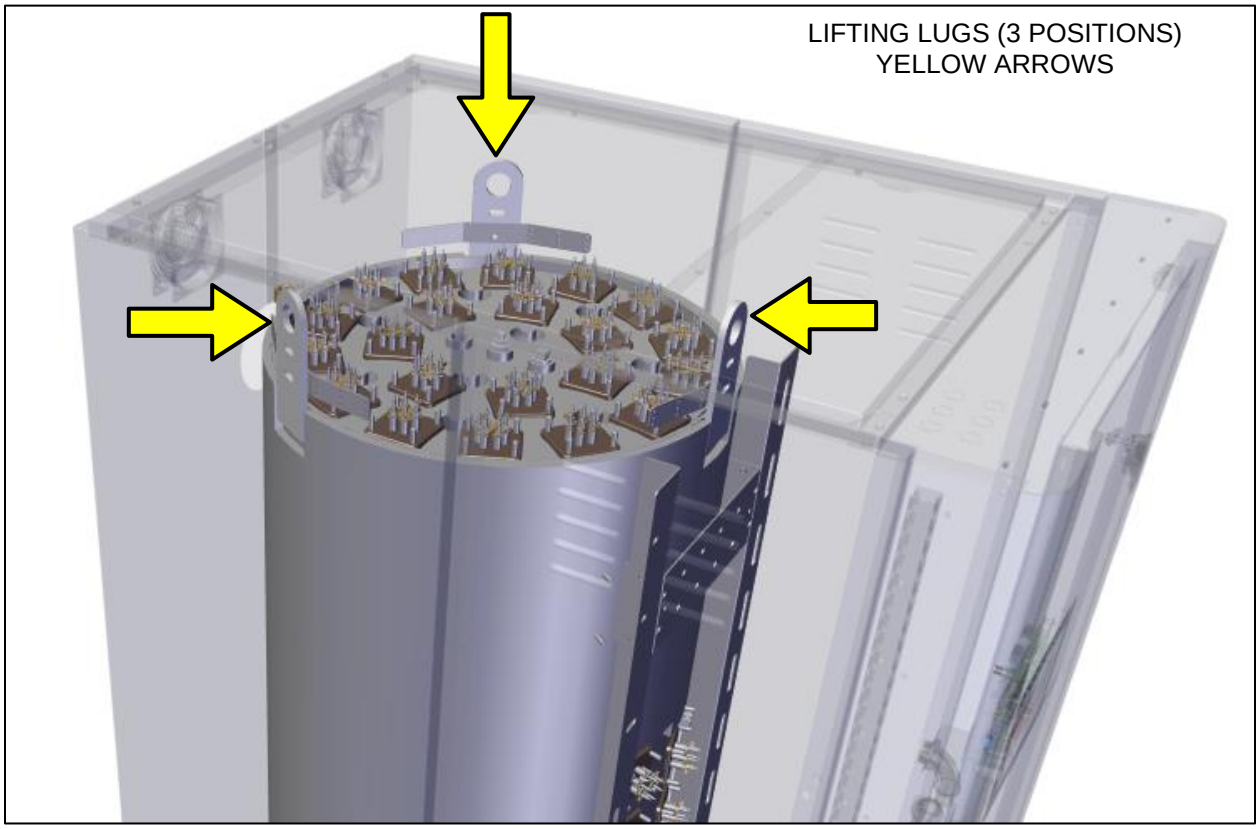


Figure 2-3: Boiler Lifting Provisions – BMK E 216-684 Shown

2.6 Supply and Return Piping

When connecting hot water outlet and cold-water inlet to building, first make sure the mating surfaces are thoroughly clean. Gaskets of appropriate size for the pipe flange must be provided in the field.

2.6.1 BMK E 216 – 684 Supply and Return Piping

Benchmark E 216–684 units have 4" (10.2 cm) 150# flange water INLET and hot water OUTLET piping.

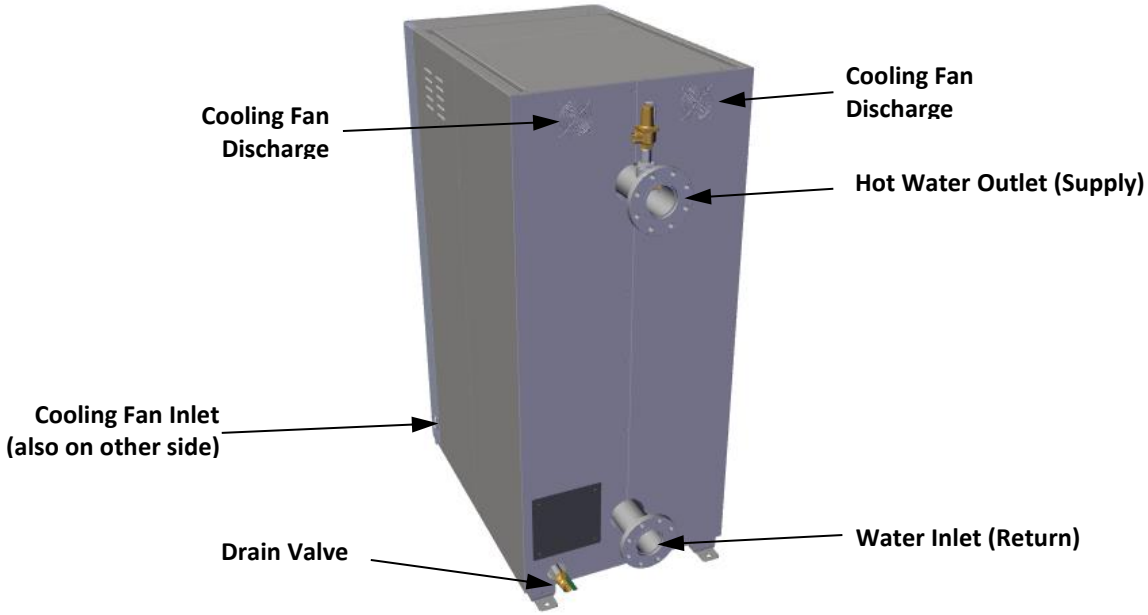


Figure 2-4: BMK E 216-684 Supply and Return Locations

2.7 Pressure Relief Valve Installation

An ASME rated Pressure Relief Valve is supplied with each Benchmark E Boiler. The pressure rating for the relief valve must be specified on the sales order. Available pressure ratings range from **30 to 150 psi (207 to 1103 kPa)**. The relief valve is installed on the hot water outlet of the boiler as shown in Figure 2-6. A suitable pipe joint compound should be used on the threaded connections. Any excess should be wiped off to avoid getting any joint compound into the valve body. The relief valve must be piped to **within 12 inches (30.5 cm)** of the floor to prevent injury in the event of a discharge. No valves, restrictions, or other blockages are allowed in the full port discharge line. In multiple unit installations the discharge lines must ***NOT*** be manifolded together. Each must be individually run to a suitable discharge location.

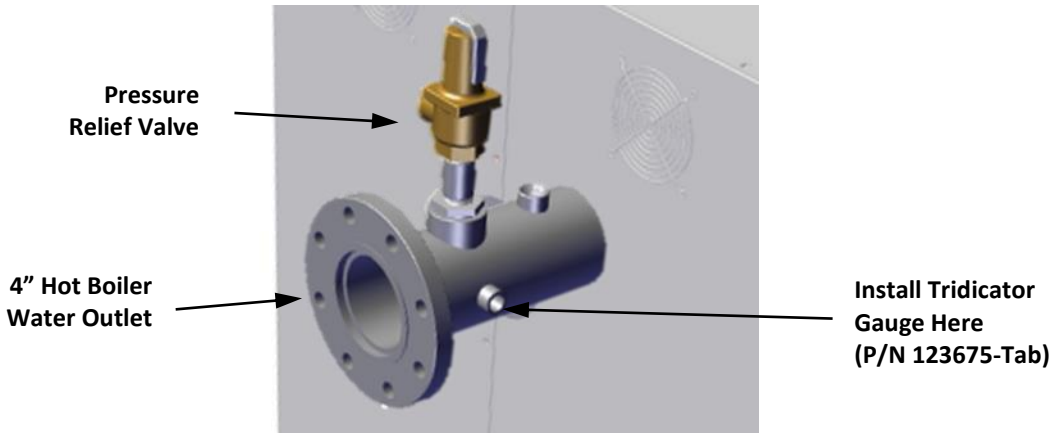


Figure 2-5: BMK E 216 – 684 P&T Relief Valve Location

2.8 AC Electrical Power Wiring

AERCO's *Benchmark Electrical Power Design Guide*, TAG-0109, must be consulted prior to connecting any AC power wiring to the unit.

Check the rating plate on the front of the unit for correct voltage, phase, and amperage. Refer to the wiring diagram for the control components mounted on the heater. Use proper wire size and branch circuit protection as required by the latest addition of the National Electrical Code, NPFA-70, or Canadian Electrical Code, C22.1, and any additional local codes. The electrical specification sheets show the number and size of power connectors furnished with the heater for minimum 90°C (194°F) copper connecting wire. Use proper wire size for the ground connection.

Use proper wire size for the ground connection. Attach to ground lug connection marked with decal "GR".

NOTE: Only use copper wire that is the correct size, as indicated. Damage resulting from use of aluminum wiring is excluded from coverage under the warranty for this unit.

IMPORTANT!

Check all wiring connections to ensure tightness prior to use.

2.8.1 Electrical Power Requirements

Benchmark E boilers are available with the following power options:

BMK Model	Voltage	Phase	Frequency	Amperage
BMK E 216	480V	3Φ	60 Hz	260
	600V	3Φ	60 Hz	208
BMK E 360	480V	3Φ	60 Hz	433
	600V	3Φ	60 Hz	347
BMK E 432	480V	3Φ	60 Hz	520
	600V	3Φ	60 Hz	416
BMK E 576	480V	3Φ	60 Hz	693
	600V	3Φ	60 Hz	555
BMK E 684	480V	3Φ	60 Hz	823
	600V	3Φ	60 Hz	659

All electrical power requirements are in the *Benchmark Electrical Power Design Guide,* TAG-0109.

2.8.2 Main Power Locations

External AC main power connections are made at the distribution blocks on the front of the unit. Open the front door to access the distribution blocks, mounted in the upper part of the unit as shown.

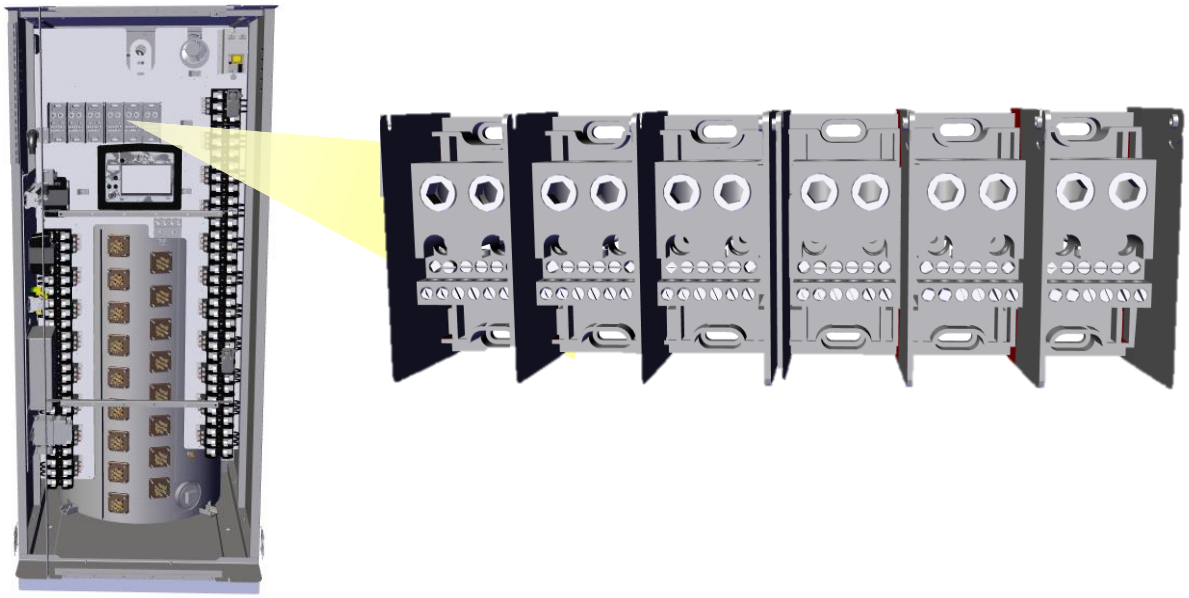


Figure 2-6: BMK E Distribution Blocks

Each unit must be connected to a dedicated electrical circuit. NO OTHER DEVICES SHOULD BE ON THE SAME ELECTRICAL CIRCUIT AS THE BOILER.

A disconnect switch must be installed on the electrical supply line, external to the unit, in an easily accessible location to quickly and safely disconnect electrical service. DO NOT attach the switch to sheet metal enclosures of the unit.

After placing the unit in service, the safety devices must be tested. The installed boiler must be electrically bonded to ground in accordance with the requirements of the authority having jurisdiction. In the absence of such requirements, the installation shall conform to National Electrical Code (NEC), ANSI/NFPA 70 and/or the Canadian Electrical Code (CEC) Part I, CSA C22.1 Electrical Code.

For electrical power wiring diagrams, see the *Benchmark E Electrical Power Design Guide*, TAG-0109.

2.8.3 BMK E Control and Power Panel Components

⚠WARNING!

Always turn off electrical service to the unit when accessing components. The cabinet contains high voltage wiring and terminals that may result in a dangerous shock causing personal injury or death. Close the control cabinet before restoring electrical service to the unit.

Many components are mounted to a metal panel inside of the enclosure. Remove the front panel to access the Power Panel. Run the electrical service to the Distribution blocks through the top of the enclosure.

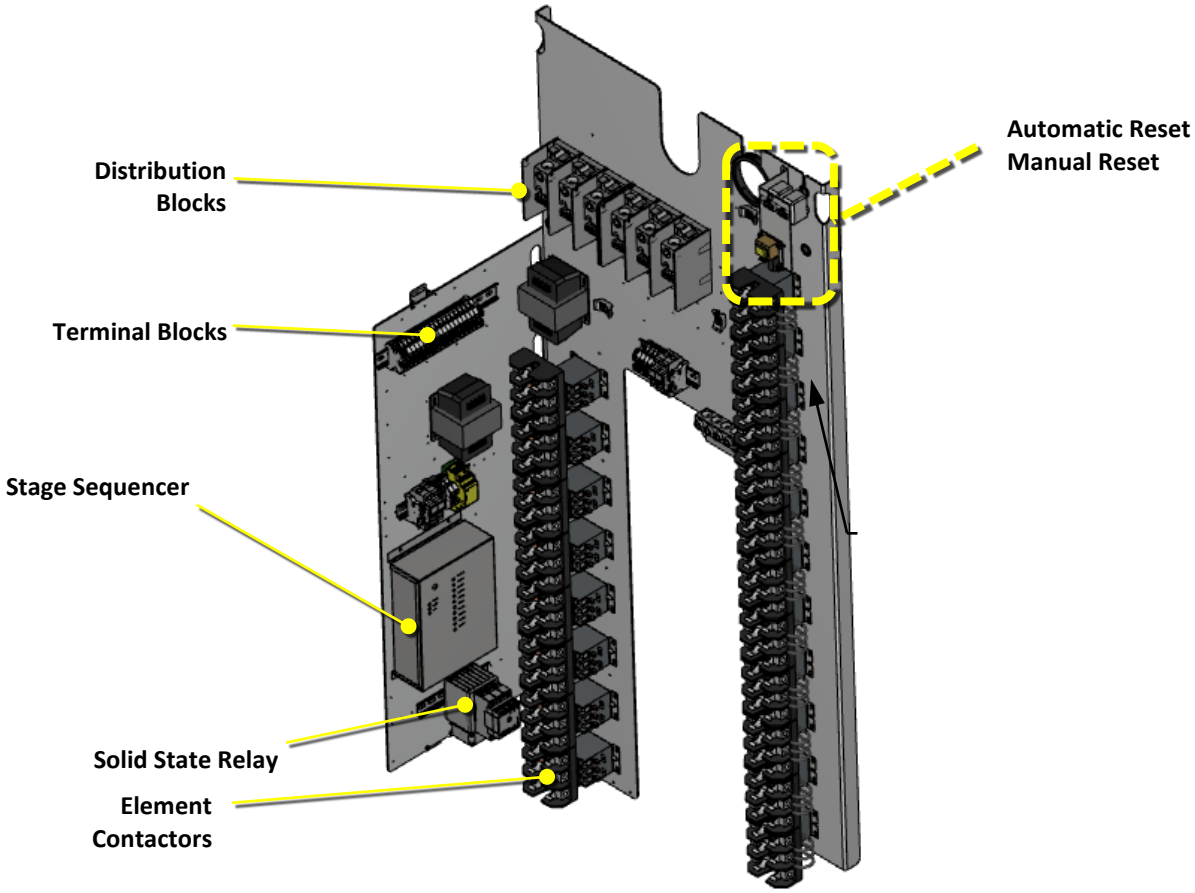


Figure 2-7 : BMK E Control and Power Panel Components

IMPORTANT!

- All electrical conduit and hardware must be installed so that it does not interfere with the removal of any unit covers, inhibit service/maintenance, or prevent access between the unit and walls or another unit.
- All electrical conduit and hardware must be installed so that it does not interfere with the removal of any unit covers, inhibit service/, or prevent access between the unit and walls or another.

2.9 Field Control Wiring – I/O Board

Each unit is fully wired from the factory with an internal operating control system. No field control wiring is required for normal operation. However, the Edge Controller used with these Benchmark E units does allow for some additional control and monitoring features. Wiring connections for these features are made on the Input/Output (I/O) board, located on the back side of the front door, and the terminal blocks located on the Control and Power Panel. All field wiring is installed from the rear of the panel by routing the wires through one of the four bushings provided on the sides of the I/O board.

NOTE: Use Figure below to determine the functions of the I/O board connections.

⚠ WARNING!
DO NOT make any connections to the I/O Box terminals labeled "NOT USED". Attempting to do so may cause equipment damage.

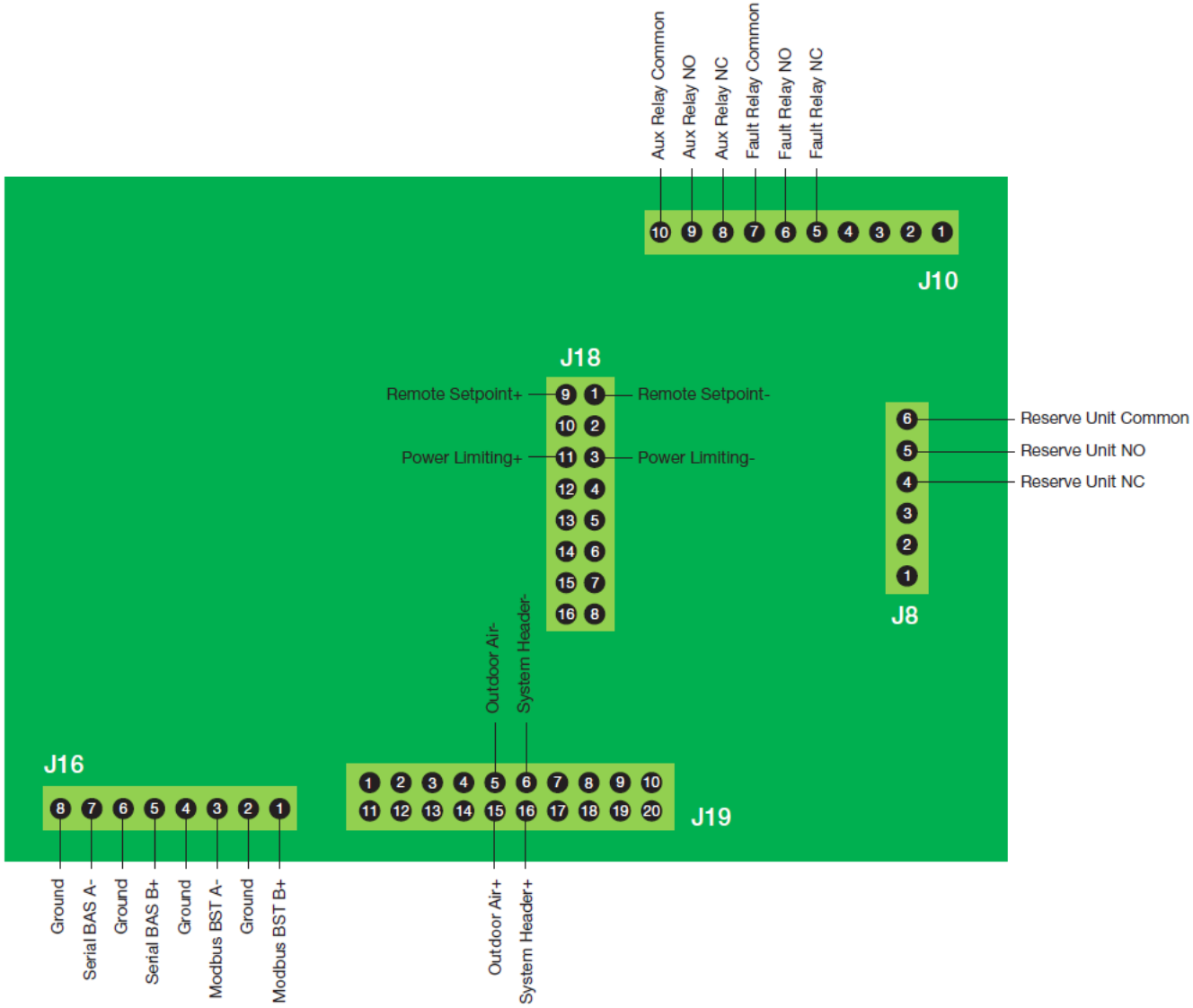


Figure 2-8: I/O Board

2.9.1 Outdoor Air & Air Sensor Common

An outdoor temperature sensor (P/N **61060**) is required for the **Outdoor Air Reset** operating mode. It can also be used with another mode if it is desired to use the outdoor sensor enable/disable feature, which allows the boiler to be enabled or disabled based on the outdoor air temperature.

The outdoor sensor may be wired **up to 200 feet (61m)** from the boiler. It is connected to the **OUTDOOR AIR +** and **OUTDOR AIR -** terminals of the I/O board (Figure 2-9). Connections must be made using twisted shielded pair of 16-24 AWG wire, such as Belden 9841. There is no polarity to observe when terminating these wires. The sensor end of the shield must be left free and ungrounded.

When mounting the sensor, it must be located on the North side of the building where an average outside air temperature is expected. The sensor must be shielded from direct sunlight as well as impingement by the elements. If a shield is used, it must allow for free air circulation.

2.9.2 Cabinet Temp Sensor

The **CABINET TEMP SENSOR** terminal is used to monitor the cabinet temperature sensor This sensor is an active part of the safety system and must be operational for safety purposes.

2.9.3 Analog In

The **ANALOG IN** terminals (+ and –) are used when an external signal is used to change the setpoint of a boiler running in **Remote Setpoint** operating mode.

Either a **0 to 20 mA**, or a **0 to 10 VDC** signal may be used to vary the setpoint. The factory default setting is **0 to 20 mA**, however this may be changed to **0 – 10 VDC** by adjusting the specified analog input DIP switch on the MCB

If voltage rather than current is selected as the drive signal, a DIP switch must be set on the MCB Board located inside the Controller. Contact AERCO for information on setting DIP switches.

All supplied signals must be floating (ungrounded) signals. Connections between the source and the boiler's I/O board (Figure 2-9) must be made using twisted shielded pair of 16-24 AWG wire, such as Belden 9841. Polarity must be maintained and the shield must be connected only at the source end and must be left floating (not connected) at the Boiler's I/O board.

2.9.4 Analog Out

The default setting in the Controller is Sequencer Output 0-20mA, and behaves as follows:

- 0-20mA ***must*** be selected for the signal output used by the Controller to modulate the stage sequencer via the I/O board terminals J13P14 and J13P15. The Analog Input 1 DIP switch on the MCB Board must be also be set to 0-20mA.
- Future use – If Boiler Sequencing Technology (BST) is enabled, the Analog Output terminals are used to drive the isolation valve. A 0-20 mA signal is used: 20 mA = closed, 0 mA = open.

2.9.5 Future Use - Serial BAS Comm (B+, Gnd, & A-)

The three **serial** communication terminals are used when the boiler plant is being controlled by a Building Automation System (BAS) using BACnet MSTP or Modbus (RS485) communication. Connections must be made using twisted shielded pair of 16-24 AWG wire, such as Belden 9841.

2.9.6 Future Use - Modbus BST Comm (B+, Gnd, & A-)

The three **RS-485** communication terminals are used when the boilers are cascaded using AERCO's on-board Boiler Sequencing Technology (BST) solution. Connections must be made using twisted shielded pair of 16-24 AWG wire, such as Belden 9841.

2.9.7 Fault Relay (Nc, Com, & No)

The fault relay is a single pole double throw (SPDT) dry contact relay having a normally open and normally closed set of relay contacts that are rated for 5 amps (resistive) at 120 VAC and 5 amps (resistive) at 30 VDC. The relay energizes when any fault condition occurs and remains energized until the fault is cleared and the **CLEAR** button is depressed. Acceptable wire gage ranges size is 12-30 AWG.

2.9.8 Auxiliary Relay Contacts (Nc, Com, & No)

Each unit is equipped with a single pole double throw (SPDT) dry contact relay that is energized when there is a demand for heat and de-energized after the demand for heat is satisfied. The relay is provided for the control of auxiliary equipment, such as pumps and louvers, or can be used as a unit status indictor (active or not active). Its contacts are rated for 120 VAC @ 5 amps. Refer to Figure 2-9 to locate the Aux Relay terminals for wiring connections. Acceptable wire gage size range is 12-30 AWG.

2.9.9 Reserve Unit Relay Contacts (Nc, Com, & No)

Each unit is equipped with a single pole double throw (SPDT) dry contact relay. If the reserve unit control function is enabled in the Edge Controller, the relay is energized when the boiler needs assistance from a reserve boiler to provide enough heat to meet system demand. The relay is de-energized after the system demand returns to normal levels. The relay enable/disables a reserve boiler via the remote interlock of the reserve boiler. The relay contacts are rated for 5 amps (resistive) at 120 VAC and 5 amps (resistive) at 30 VDC. Refer to Figure 2-9 to locate the Reserve Unit terminals for wiring connections. Acceptable wire gage size range is 12-30 AWG.

2.10 Field Control Wiring – Main Terminal Block Rail

In addition to the I/O board, some field connections, specifically the interlocks, are located on the Main Terminal Block Rail.

NOTE: Use Figure below to determine the functions of the Main Terminal Block Rail connections.

⚠ WARNING!

DO NOT make any connections to any terminals other than those specified in this section. Attempting to do so may cause equipment damage.

DO NOT attempt to power valves, pumps, or other devices using these terminal connections. Attempting to do so may cause equipment damage.

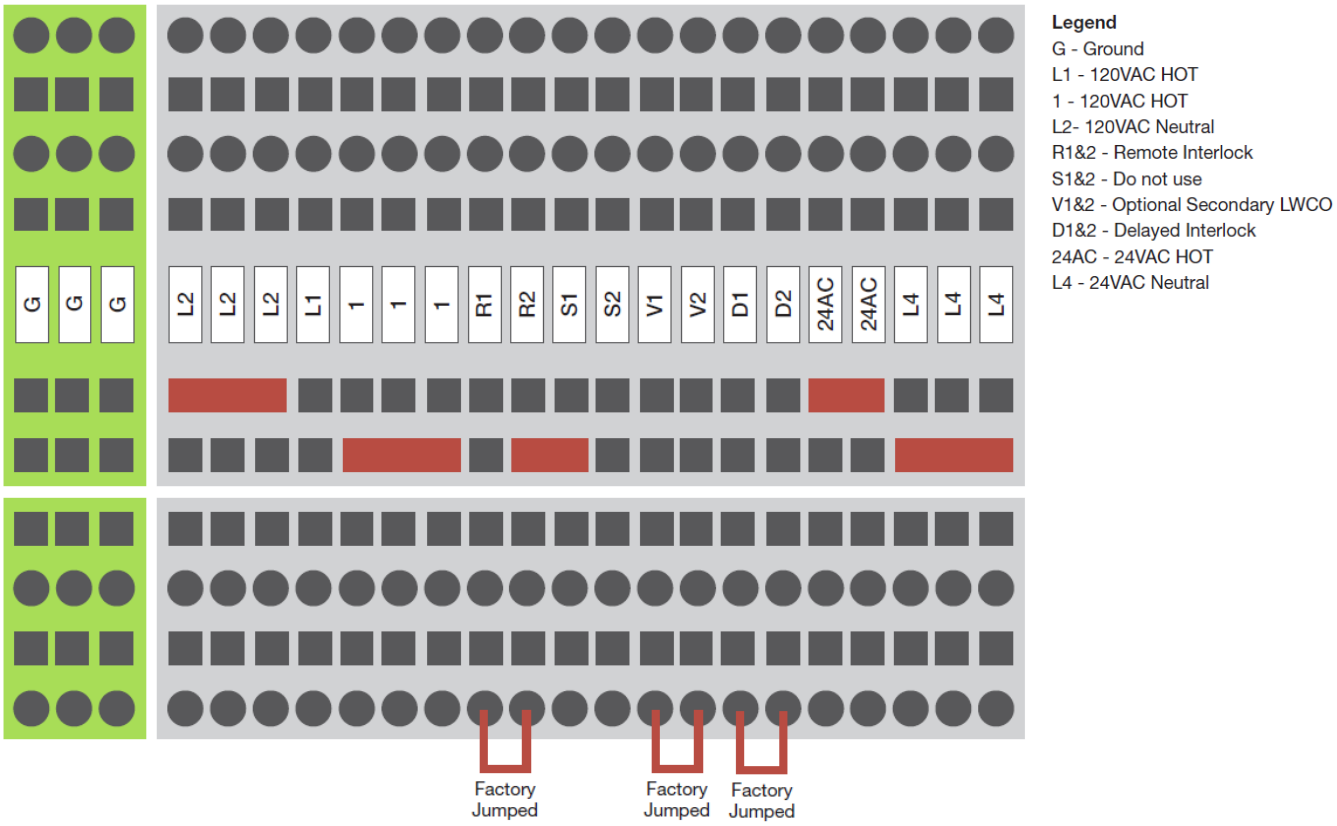


Figure 2-9: Main Terminal Block Rail

2.10.1 Interlocks

The unit has three interlock circuits for interfacing with Energy Management Systems and auxiliary equipment such as pumps, louvers or other accessories. These interlocks are called the Remote Interlock, Delayed Interlock, and Secondary LWCO, located on the terminal block shown in Figure 2-7. These interlocks, described below, are factory wired in the closed position using jumpers. Acceptable single-core wire gage size range is 12-18 AWG. Wire must be rated for at least 6A current draw.

NOTE: Delayed Interlock, Remote Interlock, and Secondary LWCO must be closed for the unit to enable.

⚠ WARNING!

Due to the power draw of the components connected in series with these interlocks, field components that are directly connected must be rated to at least 6A @ 24VAC.

Remote Interlock In (OUT & IN): The remote interlock circuit is provided to remotely start (enable) and stop (disable) the unit. The circuit is 24 VAC and comes factory pre-wired closed (jumped). The remote interlock is labeled R1 & R2 on the terminal block rail mounted on the inner left side of the cabinet.

Delayed Interlock In (OUT & IN): The delayed interlock is labeled D1 & D2 on the terminal block rail mounted on the inner left side of the cabinet. The Delayed Interlock can be used in one of two ways:

- Future use – In conjunction with the optional external sequencing valve, a component of AERCO's on-board Boiler Sequencing Technology (BST) solution A cable of the boiler's wiring harness is connected to these terminals on all units; if BST is implemented, the other end of that cable is connected to the sequencing valve.

- If BST is *NOT* implemented, the second use is typically in conjunction with the AUXILIARY RELAY CONTACTS described in Section 2.9.9, below. This interlock circuit is in the purge safety string. It can be connected to the proving device (end switch, flow switch etc.) of an auxiliary piece of equipment started by the unit's auxiliary relay. If the delayed interlock is connected to a proving device that requires time to close (make), a time delay (AUX START ON DLY) that holds the start sequence of the unit long enough for a proving switch to make (close) can be programmed.

  To use this option, you must disconnect the harness from the Delayed Interlock terminals and connect the proving device in its place.

  Should the proving switch not prove within the programmed time frame, the unit will shut down. The **Auxiliary Delay** parameter can be programmed from 0 to 240 seconds

Secondary LWCO (OUT & IN): The Secondary LWCO interlock is labeled V1 & V2 on the terminal block rail on the inner left side of the cabinet. The Secondary LWCO interlock is to connect a Secondary LWCO or other proving device (i.e. flow switch) of an auxiliary piece of equipment. Should the proving device not prove, the unit will shut down. The circuit is 24 VAC and comes factory pre-wired closed (jumped).

2.11 BST Sequencing Isolation Valve Installation

All Benchmark E units are pre-wired with a connection for an optional motorized external sequencing isolation valve (P/N **92084-TAB**). Future use - this valve is an integral component of AERCO's on-board Boiler Sequencing Technology (BST) solution. BST allows sites with multiple boilers to have one boiler, designated the "Manager," manage the other boilers at the site, designated as "Clients" in such a way that the efficiency of the entire boiler array is maximized.

When operated with the BST system, the BST Manager controls its own isolation valve and sends signals to BST Clients to open or close their isolation valves. After boiler load is satisfied, its isolation valve remains opens for a time interval defined in the controller settings. Once system load is satisfied and all Client units have stopped firing, the BST Manager opens the isolation valves of all Client units.

The implementation of BST, and the installation and use of this valve, is optional. However, **when BST is implemented**, **use of this valve is strongly recommended**.

Installation consists of installing the sequencing isolation valve in the hot water outlet pipe, and then connecting it to the pre-wired connector on the shell harness, as described below.

NOTE: The Sequencing Isolation Valve control is a pre-programmed valve, available only from AERCO. It is installed only on boilers that are part of a Boiler Sequencing Technology cascade.

2.11.1 Sequencing Isolation Valve Installation Instructions

1. Install the sequencing isolation valve in the boiler's hot water outlet pipe.

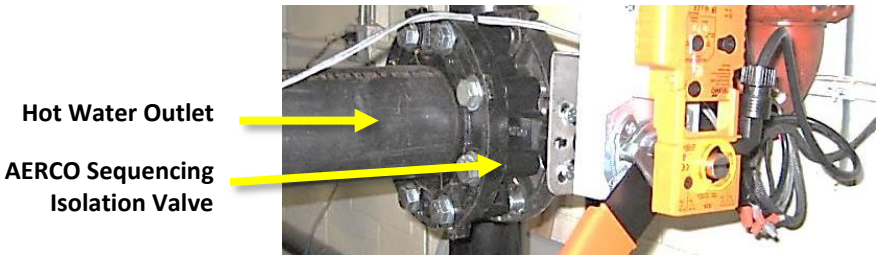


Figure 2-10: Sequencing Isolation Valve Installed

2. Find the cable with the unused Molex connector with a cap containing a jumper wire inserted in it (the jumper wire allows units that do not have a sequencing isolation valve to operate normally). The other end is connected to the I/O board, the delayed interlock terminal blocks, and to a power supply.

Figure 2-11: Sequencing Isolation Valve Molex Connector and Jumper Wire

3. Remove and dispose of the cap with jumper wire attached.
4. Plug the Molex connector into the sequencing isolation valve's connector.
5. When Sequencing Isolation Valve is used, the **Auxiliary Delay** setting must be set to 120 seconds.

SECTION 3: START SEQUENCE

IMPORTANT!

It is imperative that the initial startup of this unit be performed by factory trained personnel. Operation prior to initial startup by factory trained personnel may void the equipment warranty.

WARNING!

- All procedures in Section 2 must be completed before the initial start-up of the unit.
- Electrical voltages up to **208, 240, 480 or 600 VAC (BMK E 216 - 684) and 24 volts DC** may be present. Electrical cabinet must be closed at all times except during maintenance and servicing.
- **Do not attempt to dry fire the unit.** Starting the unit without a full water level can damage the unit and may result in injury to personnel or property damage. This situation will void any warranty.
- Initial startup of the unit must be performed by AERCO factory trained personnel. Operation prior to initial startup by factory trained personnel may void the equipment warranty.

3.1 Start Sequence

When the Enable/Disable switch on the Edge Controller is set to the ***Enable*** position, it checks all safety switches and interlocks to ensure they are closed. These switches include:

- Primary Low Water Cutoff switch
- Secondary LWCO (optional, factory-jumped)
- High Temperature Limit switch
- Operating Temperature Limit switch
- Cabinet Door switch
- Remote Interlock (optional, factory-jumped)
- Delayed Interlock (optional, factory-jumped)

If all the above switches are closed, the READY light (above the Enable/Disable button) will light when the button is in the **Enable** position and the unit will be in the STANDBY mode.

NOTE: If any of the safety device switches are open, or the required conditions are not observed throughout the start sequence, appropriate fault messages will be displayed.

When there is a demand for heat, the following events occur:

1. The Controller's Enable/Disable button status indicator will light.
2. The unit checks all safety switches and interlocks listed at the beginning of this section.
3. Auxiliary Delay occurs for a configurable length of time and Delayed Interlocks are closed.
4. Once all required safety device switches are closed, the demand relay energizes and turns on the stage sequencer.
5. With the unit firing properly, it will be controlled by the temperature control circuitry. The boiler's target power output will continuously display on the Controller's Unit Dashboard screen.
6. Once the demand for heat has been satisfied, the Edge Controller will turn deenergize the demand relay, disabling the stage sequencer. ***Standby*** is displayed.

SECTION 4: INITIAL STARTUP

4.1 Initial Start-Up Requirements

- Complete the installation per the *Section 2.* Starting a unit without the proper piping or electrical systems can be dangerous and may void the product warranty.
- Set proper controls and limits in the Edge Controller.

Initial start-up consists of the following:

- Element continuity tests (Section 4.3)
- Test safety devices (Section 5)

Start-up must be successfully completed before putting the unit into service. The start-up instructions below should be followed precisely in order to operate the unit safely.

Initial unit start-up ***must be*** performed by AERCO factory trained personnel, who are trained in the start-up and service of Benchmark E boilers.

An AERCO Startup Sheet, included with each Benchmark E unit, must be completed for each unit for warranty validation and a copy must be returned promptly to AERCO via e-mail at: ***STARTUP@AERCO.COM***.

⚠ WARNING!

Do NOT dry fire the unit. Starting the unit without full water level can damage the unit and may result in injury to personnel and/or property damage. This situation will void any warranty.

4.2 Initial Start-Up Procedure

⚠WARNING!

Always turn off all electrical service to the unit when accessing controls inside the cabinet. The cabinet contains high voltage wiring and terminals. If the electrical service is not turned off, and these wires or terminals are touched, a dangerous shock causing personal injury or death. Close the control cabinet before restoring electrical service to the unit.

1. Use a multimeter to check resistance to ground between all element terminals and the element mounting flange. ***See section 4.3.***
   - Fill the Benchmark E with water. Open the relief valve to allow air to escape.
   - Check inside of electrical enclosure for leaks while the unit is full of water and at pressure. Contact tech service if a leak is observed.
   - If leaks are present, tighten all four nuts uniformly on the element mounting flange in a crisscross pattern. Tighten one nut, then the nut diagonally across from the first nut. Next, tighten the nut next to the second nut, and then the nut diagonally across from the third nut. Repeat this sequence until all nuts are tight. Each nut should be tightened to 11-foot pounds of torque. To avoid warping the flange, do not over tighten.

IMPORTANT!

All leaks must be corrected prior to turning on the electricity to avoid damage to electrical components.

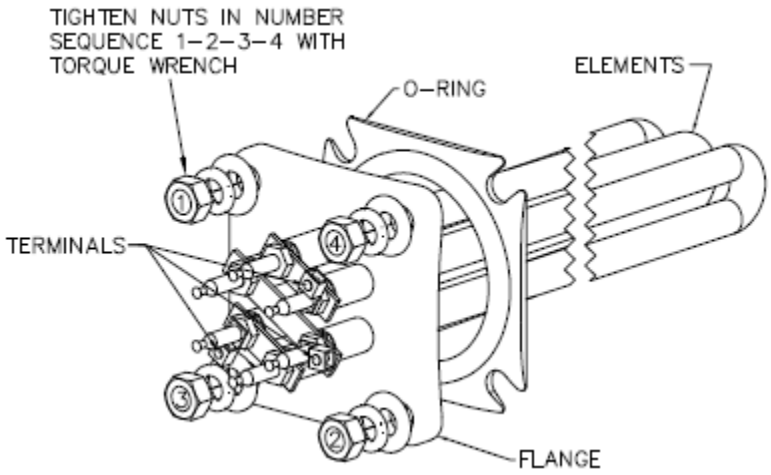


Figure 4-1: Electric Element (Design May Vary)

NOTE: 3 phase elements have 6 terminals.

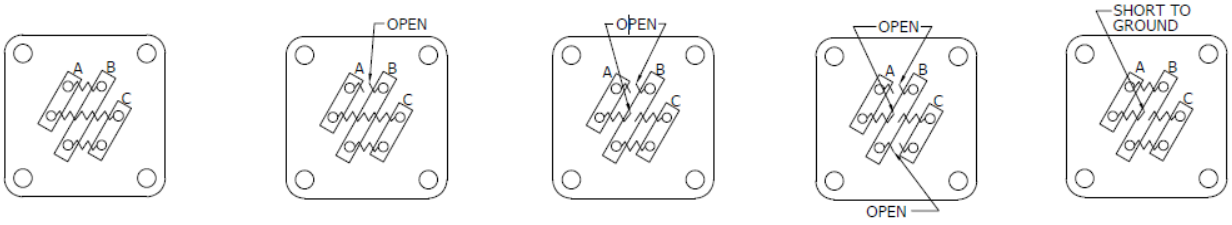
2. The unit must be full of water at system design pressure and with flow before turning on the electricity. If elements are energized without water in the unit, they will burn out immediately. Energizing elements in a static, atmospheric tank of water may also lead to element failure.

IMPORTANT
Dry-starting the unit will void all warranties.

3. Check the tightness on all electrical connections before turning the unit on.
4. Energize the manual disconnect switch. Check for proper voltage (with a voltmeter) on power circuit. Voltage should not vary more than 5% from voltage shown on data plate. If voltage exceeds these limits, immediately turn off main disconnect and contact utility company.
5. Check for proper voltages on the control circuit.
6. Check for proper amperage with ammeter on power circuit. Amperage should not vary more than 5%, when under full load, from amperage shown on data plate. *See Table 2 on Figure 4-5*. If amperage exceeds these limits, immediately turn off main manual disconnect and refer to Section 8.1.
7. Check magnetic contactors for noise. If noisy, i.e., buzzing or chattering, turn off main power disconnect, disassemble contactor and blow out foreign particles. Drill filings, dirt or other particles can cause pitting of points which will in turn burn out the contactor and/or wire. Extra care has been taken during fabrication and inspection for cleanliness, however, field installation is often responsible for debris collecting on the contactor points.
8. After startup and with the unit operating, allow the unit to reach the desired setpoint and de-energize the heating elements. This will check for proper operation of the operating controls. Ensure that hydronic circulation pumps are operating before starting up the unit.

IMPORTANT
After approximately 30 minutes of operation, turn off all power to the unit. With main disconnect off, check each wire connection and fuse clip for elevated temperature. If an elevated temperature is noted, there is a loose connection at the point of greatest heat. All connections must be tight for proper performance.

4.3 Element Continuity Checks



NOTE: Element wire leads must be disconnected to prevent false OHM readings.

ELEMENT RATING		CHECK OPEN	I. OHM READING NORMAL	II. OHM READING 1 LEG OPEN	III. OHM READING 2 LEGS OPEN	IV. OHM READING 3 LEGS OPEN	V. OHM READING TERMINAL TO FLANGE
kW	VOLT	COILS					
18	600	A-B	40	120	∞	∞	Depending on the severity of the short, the OHM reading may vary from zero, (direct short) to several hundred ohms (partial short). In any case where the OHM reading is not infinity, the element should be replaced.
		B-C	40	60	60	∞	
		C-A	40	60	∞	∞	
18	480	A-B	26	78	∞	∞	
		B-C	26	39	39	∞	
		C-A	26	39	∞	∞	

Figure 4-2: Typical Current Measurements

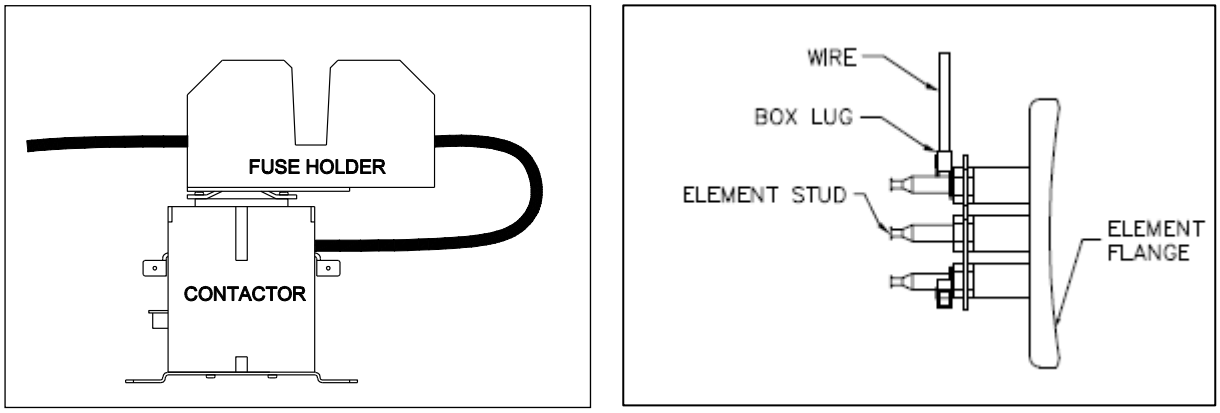


Figure 4-3: Typical Wire Terminations

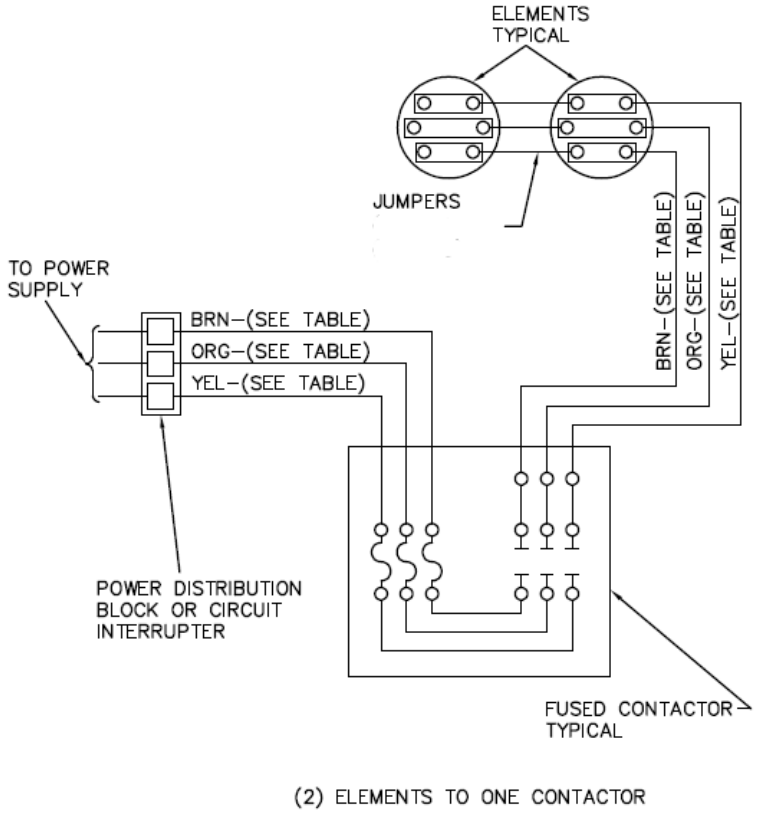


Figure 4-4: Typical Three Phase Wiring

REQUIRED WIRE SIZE	
Contactor Fuseholder Rating	Wire Size
600V – 60A	6 AWG

TORQUEING REQUIREMENTS		
Wire Size	Terminal Type	In-lbs
6 AWG	BOX	45

KW-VOLTAGE	3 Ø AMPS PER ELEMENT	
	AMPS PER LEG	AMPS TOTAL
18 kW-600V	18	18
18 kW-480V	22	22
TABLE 2		

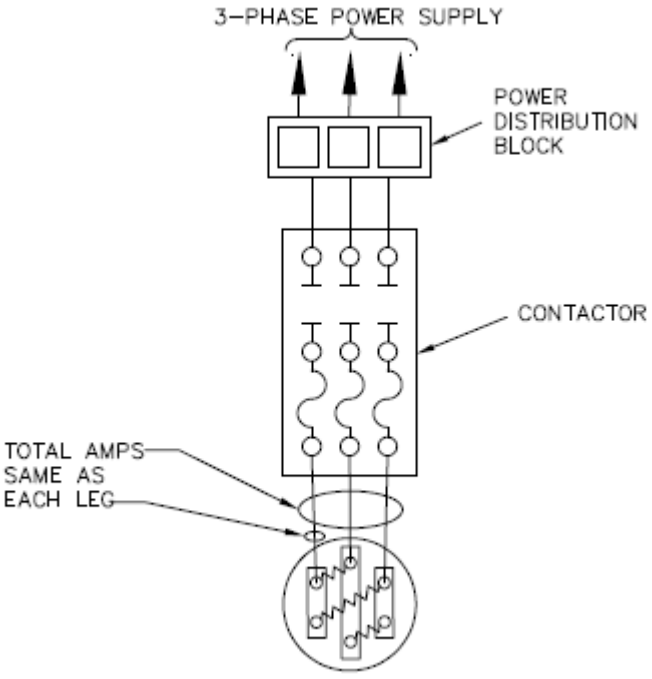


Figure 4-5: Typical Three Phase Wiring

NOTE: Elements are usually wired to contactors in groups, in order to maintain an amperage draw of close to, but not more than, 50 amps per contactor.

SECTION 5: SAFETY DEVICE TESTING

5.1 Testing of Safety Devices

Periodic safety device testing is required to ensure that the control system and safety devices are operating properly. The boiler control system comprehensively monitors all safety devices before, during and after the start sequence. The following tests check to ensure that the system is operating as designed.

Operating controls and safety devices should be tested on a regular basis or following service or replacement. All testing must conform to local codes such as ASME CSD-1.

⚠ WARNING!

Always turn off all electrical service to the unit when accessing controls inside the cabinet. The cabinet contains high voltage wiring and terminals. If the electrical service is not turned off, and these wires or terminals are touched, a dangerous shock causing personal injury or death. Close the control cabinet before restoring electrical service to the unit.

⚠ WARNING!

Electrical voltages up to **208, 240, 480 or 600 VAC (BMK E 216 - 684)** and **24 volts DC** may be used in this equipment. Power must be removed prior to performing wire removal or other test procedures that can result in electrical shock.

5.2 Low Water Level Fault Test

To simulate a low water level fault, proceed as follows:

1. Set the Controller's **Enable/Disable** button to **Disable**.
2. Close the water shut-off valves in the supply and return piping to the unit.
3. Slowly open the drain valve on the rear of the unit. If necessary, the unit's relief valve may be opened to aid in draining.
4. Continue draining the unit until a ***Low Water Level*** fault message is displayed and the **READY** light on the Enable/Disable turns off.
5. Set the Controller's **Enable/Disable** button to **Enable**. The **READY** light should remain off and the unit should not start. If the unit does start, shut the unit off immediately and refer fault to qualified service personnel.
6. Close the drain and pressure relief valve used in draining the unit.
7. Open the water shut-off valve in the return piping to the unit.
8. Open the water supply shut-off valve to the unit to refill.
9. After the shell is full, press the **LOW WATER LEVEL – RESET** button to reset the low water cutoff.
10. Press the **CLEAR** button to reset the **FAULT** LED and clear the displayed error message.
11. Set the **Enable/Disable** button to **Enable**. The unit is now ready for operation.

5.3 Automatic Reset Fault Test

A high-water temperature fault is simulated by adjusting the **Automatic Reset Over-Temperature** switch.

1. Remove power from the unit via the external disconnect switch.
2. Lower the Over-Temperature switch setting to at least 10°F below the desired test setpoint.
3. Close the cabinet door, then enable power from the unit via the external disconnect switch.
4. Start the unit in the normal operating mode. Ensure the setpoint is set higher than the Over-Temperature switch by at least 10°F. Allow the unit to operate normally.
5. Once the actual outlet temperature reaches the lowered Over-Temperature switch setting, the unit should shut down. The FAULT indicator should start flashing and a ***Op. Temp Limit Control Open*** *fault* message should be displayed. It should not be possible to restart the unit while the actual outlet temperature is above the setpoint of the Over-Temperature switch.
6. Remove power from the unit via the external disconnect switch.
7. Reset the adjustable Over-Temperature switch to its original setting.
8. Close the cabinet door, then enable power from the unit via the external disconnect switch. The unit should start once the Temperature Limit switch setting is above the actual outlet water temperature.

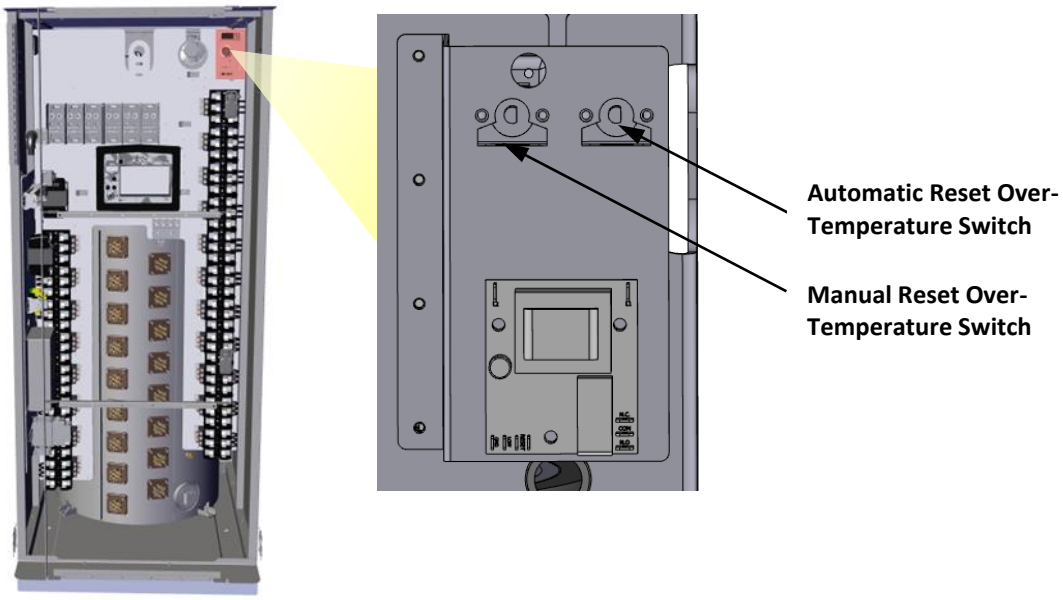


Figure 5-1: Temperature Limit Switch Location – BMK E 216 – 684 Shown

5.4 Manual Reset Fault Test

A high-water temperature fault is simulated by adjusting the **Manual Reset Over-Temperature** switch.

1. Follow steps 1-4 on the Automatic Reset Fault Test, above.
2. Once the actual outlet temperature reaches the lowered Over-Temperature switch setting, the unit should shut down. The FAULT indicator should start flashing and a ***High Temp Limit Control Open*** fault message should be displayed. It should not be possible to restart the unit while the actual outlet temperature is above the setpoint of the Over-Temperature switch.
3. Remove power from the unit via the external disconnect switch.

4. Reset the adjustable Over-Temperature switch to its original setting.
5. Close the cabinet door, then enable power to the unit via the external disconnect switch.
6. Press the **CLEAR** button to reset the **FAULT** LED and clear the displayed error message.

5.5 Interlock Tests

The unit is equipped with three interlock circuits called the Remote Interlock, Delayed Interlock, and Secondary LWCO. Terminal connections for these circuits are located on the terminal block rail on the inside left of the cabinet. (see Section 2.8.3) and are labeled D1 & D2, R1 & R2, and V1 & V2, respectively.

These circuits can shut down the unit in the event an interlock is opened. These interlocks are shipped from the factory jumpered (closed). However, they may be utilized in the field as a remote stop and start, an emergency cut-off, or to prove that a device such as a pump, gas booster or louver is operational.

5.5.1 Remote Interlock Test

1. Remove power from the unit via the external disconnect switch.
2. Open the cabinet and locate the R1 & R2 terminals.
3. If there is a jumper across the R1 & R2 terminals, remove one side of the jumper. If the interlock is being controlled by an external device, either open the interlock via the external device or disconnect one of the wires leading to the external device.
4. Close the cabinet door, then enable power to the unit via the external disconnect switch.
5. The **READY** light on the **Enable/Disable** button should be off. Set the button to **Enable**. The **READY** light should remain off. A ***Remote Interlock Open*** message should be displayed.
6. Remove power from the unit via the external disconnect switch.
7. Reconnect the jumper across the R1 & R2 terminals (or the external device).
8. Close the cabinet door, then enable power to the unit via the external disconnect switch. The ***Remote Interlock Open*** message should automatically clear, and the unit should restart.

5.5.2 Delayed Interlock Test

1. Remove power from the unit via the external disconnect switch.
2. Open the cabinet and remove the wire connected to the D1 terminal.
3. Close the cabinet door, then enable power to the unit via the external disconnect switch.
4. The **READY** light on the **Enable/Disable** button should be off. Set the button to **Enable**. The **READY** light should remain off. A ***Delayed Interlock Open*** message should be displayed.
5. Remove power from the unit via the external disconnect switch.
6. Reconnect the wire or removed in step 3 to restore the interlock.
7. Close the cabinet door, then enable power to the unit via the external disconnect switch.
8. Press the **CLEAR** button to reset the fault. The unit should start.

5.5.3 Secondary LWCO Test

1. Remove power from the unit via the external disconnect switch.
2. Open the cabinet and locate the V1 & V2 terminals.
3. If there is a jumper across the V1 & V2 terminals, remove one side of the jumper. If the interlock is being controlled by an external device, either open the interlock via the external device or disconnect one of the wires leading to the external device.
4. Close the cabinet door, then enable power to the unit via the external disconnect switch.

5. The **READY** light on the **Enable/Disable** button should be off. Set the button to **Enable**. The light should remain off. A ***Secondary Low Water Level*** message should be displayed.
6. Remove power from the unit via the external disconnect switch.
7. Reconnect the jumper across the V1 & V2 terminals (or the external device).
8. Close the cabinet door, then enable power to the unit via the external disconnect switch. The ***Secondary Low Water Level*** message should automatically clear, and the unit should restart.

5.6 Safety Pressure Relief Valve Test

Test safety Pressure Relief Valve in accordance with ASME Boiler and Pressure Vessel Code, Section VI.

5.7 Cabinet Door Switch

⚠ WARNING!

Electrical voltages up to **208, 240, 480 or 600 VAC (BMK E 216 - 684)** and **24 volts AC and DC** may be in this equipment. Remove power before performing wire removal or other tests that can result in electrical shock.

The cabinet door switch is designed to disable the unit and prevent the elements from energizing.

1. Start the unit in the normal operating mode.
2. Open the cabinet door slightly. Do not reach into or enter the cabinet.
3. The unit should shut down and display a ***Cabinet Door Open*** fault message on the Edge controller.
4. Ensure the door is not in contact with the door switch located on the top rail of the door frame.
5. Close the cabinet door to reconnect the cabinet door switch.
6. Press the **CLEAR** button to reset the fault. The unit should start.

SECTION 6: STANDALONE MODES OF OPERATION

Benchmark E standalone boilers are capable of operating in any one of four different modes:

- Outdoor Air Reset
- Constant Setpoint
- Remote Setpoint (BAS Point)
- Remote Setpoint (Analog Input)

The following sections provide descriptions of each of these operating modes. All temperature related parameters are at their factory default values, which work well in most applications. However, it may be necessary to change certain parameters to customize the unit to the system environment. After reading this section, parameters can be customized to suit the needs of the specific application.

6.1 Outdoor Air Reset Mode

The **Outdoor Air Reset** operating mode is based on outside air temperatures. As the outside air temperature decreases, the supply header temperature will increase and vice versa. For this mode, it is necessary to install an outside air sensor. To enable this operating mode, go to **Settings > Advanced Setup > Standalone Mode > Application Settings** and select **Outdoor Air Reset** as the Operating Mode.

6.1.1 Outdoor Air Temperature Sensor Installation

The outdoor air temperature sensor must be mounted on the North side of the building in an area where the average outside air temperature is expected. The sensor must be shielded from the sun's direct rays, as well as direct impingement by the elements. If a cover or shield is used, it must allow free air circulation. The sensor may be mounted **up to 200 feet (61m)** from the unit. Connections are made at the Input/Output (I/O) board.

The Outdoor Air Temp Sensor must be connected to the **OUTDOOR AIR +** and **OUTDOOR AIR -** terminals on the I/O board. Use shielded 16 to 24 AWG wire for connections.

For additional information on wiring, see Section 2.9.1.

6.1.2 Outdoor Reset Mode Startup

Startup in the **Outdoor Reset** mode is accomplished as follows:

> **NOTE:** It is required to have an outdoor sensor for the Outdoor reset. A PT1000 header sensor or boiler supply sensor can be used depending on the plant configuration.

1. Go to: **Settings > Advanced Setup > Standalone Mode > Application Settings**
2. Press the **Operating Mode** parameter and choose **Outdoor Air Reset**.

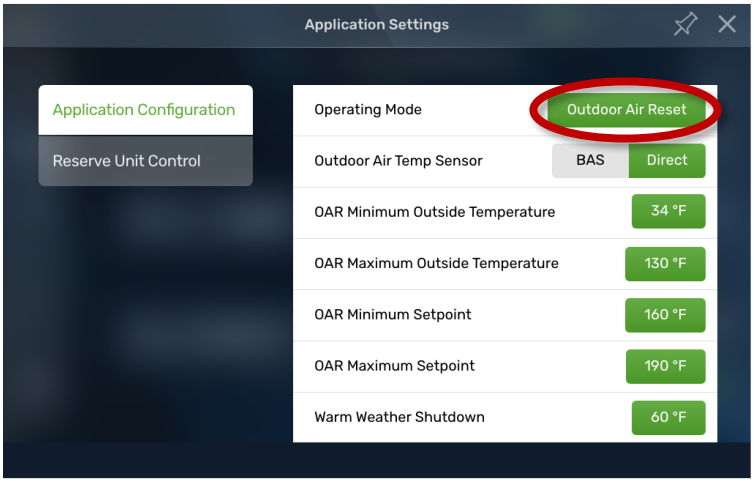


Figure 4-1: Outdoor Air Reset

3. Set the following parameters to define the total outside air temperature span for Setpoint control:
    - **OAR Minimum Outside Temperature:** The minimum outside temperature the system can read; it is tied to the OAR Max Setpoint. For example, if OAR Min Outside Temp is -5°F and OAR Max Setpoint is 180°F, when the outside temperature is -5°F or below, the system will supply 180°F.
    - **OAR Maximum Outside Temperature:** Outdoor Air Reset Maximum Outside Temperature that the system will operate to. For example: if set to 60°F, the boiler will operate between 60°F outside temperature and OAR Min Outside Temp setting.
4. Set the following parameters to define the Setpoint curve, which will be used to yield a desired setpoint for a given outside temperature:
    - **OAR Max Setpoint:** Maximum allowable setpoint
    - **OAR Min Setpoint:** Minimum allowable setpoint

Set the **Warm Weather Shutdown** parameter to the threshold outside temperature above which the unit shuts down. For example, if set to 65°F, when the outside temperature goes above 65°F, the unit goes into standby. The unit will then restart when the temperature falls below 60°F.

6.2 Constant Setpoint Mode

The **Constant Setpoint** mode (the default) is used when a fixed header temperature is desired. Common uses of this mode of operation include water source heat pump loops, and indirect heat exchangers for potable hot water systems or processes.

No external sensors are required to operate in this mode. While it is necessary to set the desired setpoint temperature, it is not necessary to change any other temperature-related functions. The unit is factory preset with settings that work well in most applications. Prior to changing any temperature-related parameters, other than the setpoint, it is suggested that an AERCO representative be contacted.

The setpoint temperature of the unit is adjustable from 50°F to 220°F (10°C to 104.4°C).

To set the unit to **Constant Setpoint** mode:

1. Go to: **Settings > Advanced Setup > Standalone Mode > Application Settings**
2. Press the **Operating Mode** parameter and select **Constant Setpoint**.
3. Press the **Setpoint** parameter and enter the desired setpoint.

6.3 Remote Setpoint Mode

The unit's setpoint can be remotely controlled by an Energy Management System (EMS) or Building Automation System (BAS). The **Remote Setpoint** can be driven by a BAS point or analog input.

When using an **Analog Input** signal, the **Remote Setpoint** can be driven by a current or voltage signal.

NOTE: See Section 2.9 for field wiring instructions.

When using the **Analog Input** setpoint source, the default setting, **0 - 20 mA**, is used to change the unit's setpoint via a signal sent by an EMS or BAS. To use a **0 – 10 V** signal, the settings Analog Input DIP switch setting must be adjusted to **VOLTAGE**, and the controller must be configured for voltage.

The steps below provide instruction on how to configure the **Analog Input** parameters.

1. Go to: **Settings > Advanced Setup > Standalone Mode > Application Settings**
2. Press the **Operating Mode** parameter and choose **Remote Setpoint**.
3. Select **Analog Input** for the **Setpoint Source** parameter.
4. Select the desired signal type. Ensure that the analog input DIP switch on the MCB matches the signal type configured in the controller.
5. The remote setpoint signal can be adjusted with the following parameters:
    - **Setpoint Minimum Signal:** The minimum analog input signal the system can read; it is tied to the Setpoint Minimum Limit. For example, if Setpoint Minimum Signal is 4 mA and Setpoint Minimum Limit is 60°F, when the analog signal is 4 mA or below, the setpoint will be 60°F.
    - **Setpoint Maximum Signal:** The maximum analog input signal the system can read; it is tied to the Setpoint Maximum Limit. For example, if Setpoint Maximum Signal is 20 mA and Setpoint Maximum Limit is 180°F, when the analog signal is 20 mA or above, the setpoint will be 180°F.
    - **Setpoint Signal Timeout:** If there is a loss of signal for the specified duration, the unit will apply the failsafe setpoint (or shutdown) as specified in **Settings > Advanced Setup > Comm & Failsafe > BAS Comm Failsafe** settings.
    - **Setpoint Minimum Limit:** The minimum allowable setpoint.
    - **Setpoint Maximum Limit:** The maximum allowable setpoint.

SECTION 7: MAINTENANCE

7.1 Maintenance Schedule

All Benchmark E boilers require regular routine maintenance to keep up efficiency and reliability. For best operation and life of the unit, the following routine maintenance procedures should be performed in the time periods specified in Table 7-1. For a complete inspection check list see ASME CSD-1 chart.

⚠ WARNING!

Prior to servicing, ensure that the following guidelines are strictly observed:

- Follow all Lockout/Tagout protocols in effect at the site.
- Turn off the electrical disconnect switch and AC supply circuit breaker.
- Allow the unit to cool to a safe water temperature to prevent burning or scalding.

TABLE 7-1: Maintenance Schedule

SEC	Item	Operation	Interval	Labor Time
7.2	Electrical Connections	Inspect	Monthly	15 mins.
7.3	Electric Elements	Check	Every 6 Months	30-60 mins.
7.4	Electric Elements	Remove & Clean	See Section 7.4	
7.5	Testing of Safety Devices		See Section 7.4	45 mins.
7.6	Periodic Testing	Routine verification of functionality, various schedule		

7.2 Electrical Connections

Check all electrical connections approximately one or two weeks after the initial start-up to ensure tightness. High current connections such as element and contactor connectors should be manually checked by attempting to tighten. Heating and cooling occurring during use can loosen connections. Visually inspect wire terminal points for any discoloration on a monthly basis. Discoloration is likely due to a loose connection at the point nearest to the discoloration. Check contactors periodically and clean if necessary and repair or replace pitted points caused by foreign particles. Check fuses periodically for continuity and replace if necessary with the same type and rating.

7.3 Electrical Elements Continuity Check

Perform element continuity checks per section 4.3.

7.4 Cleaning Electric Elements

Electric immersion INCOLOY® sheath elements are wound at high wattage ratings and must be completely covered by water while in operation, or else they will overheat and burn out. Typically, closed loop systems do not see significant scale buildup. However, if there are leaks in the system, continuous makeup water may be introduced to the system and result in increased scale buildup. Therefore, it is recommended to monitor the system for leaks and occasionally inspect elements for scale buildup.

Elements are cleaned by soaking them in a scale dissolving solution. A 30” piece of four or six inch PVC pipe with a cap on one end makes an ideal container for element cleaning. (See Figure 7-1) Contact a chemical supply house for guidance on the proper cleaning solution for your area.

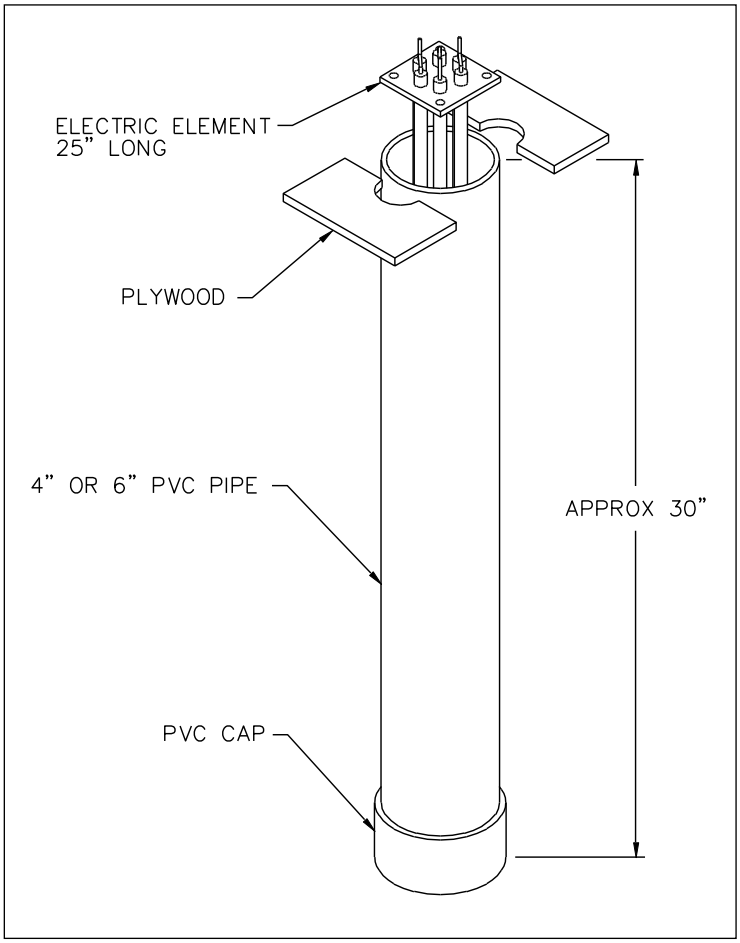


Figure 7-1: Element Cleaner

7.5 Safety Device Testing

Systematic and thorough tests of the operating and safety devices should be performed to ensure that they are operating as designed. Certain code requirements, such as ASME CSD-1, require that these tests be performed on a scheduled basis. Test schedules must conform to local jurisdictions. The results of the tests should be recorded in a logbook. See Section 6: Safety Device Testing in this guide for a description and instructions for performing these tests.

7.6 Recommended Periodic Testing

ITEM	FREQUENCY	ACTION BY	REMARKS
Gauges, monitors and indicators	Daily	Operator	Visual inspection and record readings in operator log
Instrument and equipment settings	Daily	Operator	Visual check against factory recommended specifications
	Weekly	Operator	Verify factory settings
Power Output Control	Semi-Annually	Service Tech	Verify factory settings
Low water level cut off and alarm	Weekly	Operator	See Section 5.2: *Low Water Level Fault Test*
Slow drain test	Semi-Annually	Operator	Perform a slow drain test in accordance with ASME Boiler and Pressure Vessel Code, Section IV.
High water temp. safety control test	Annually	Service Tech	See Section 5.4: *Manual Reset Fault Test*
Operating controls	Annually	Operator	See *Edge Controller Manual, OMM-0170*
Safety valves	As required	Operator	Check per A.S.M.E. Boiler and Pressure Vessel Code, Section IV.

7.7 Recommended Spares

- Contactor Fuses
- Spare Element(s)
- Low voltage fuses
- LWCO Probe

7.8 Shutting Boiler Down for Extended Period

If the boiler is to be taken out of service for an extended period of time (one year or more), the following instructions must be followed.

1. Set Enable/Disable switch on the front panel to **Disable** to shut down the boiler's operating controls.
2. Disconnect AC power from the unit via the disconnect switch. It is recommended to lock out the disconnect switch during prolonged shutdown.
3. Close the water supply and return valves to isolate boiler.
4. Open relief valve to vent water pressure.
5. Open the drain valve and drain all water from the unit.
6. If the temperature in the storage location will ever get below freezing, **for even a short time**, you must drain ***all*** water from the unit ***before*** the temperature falls below freezing. Step 5 is not sufficient, as it leaves some water in the bottom of the heat exchanger chamber. You must then use a suction pump inserted through the inspection ports to remove ***all*** water from the bottoms of the heat exchanger chamber and base assembly.

⚠ WARNING!
If the temperature falls below freezing, failure to drain **all** water can cause damage to the equipment.

7.9 Returning The Boiler to Service After Shutdown

After a prolonged shutdown (one year or more), the following procedures must be followed:

1. Review installation requirements included in Section 2.
2. Inspect all piping and connections to the unit.
3. Perform initial startup per Section 4 of this guide.
4. Perform the instructions in Section 5: *Safety Device Testing*, above, and all scheduled procedures described Section 7: *Maintenance*.

SECTION 8: TROUBLESHOOTING

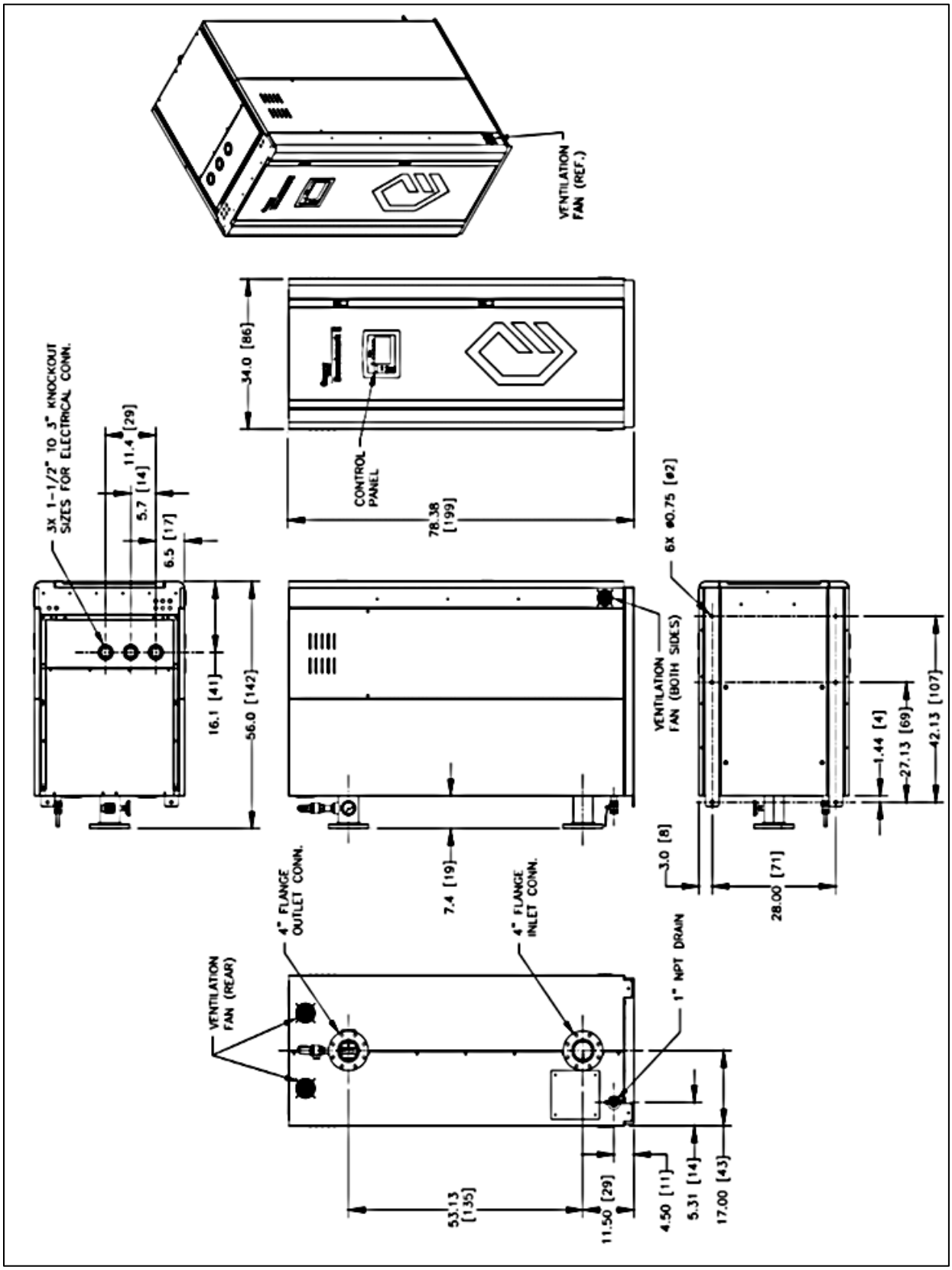
Boiler Troubleshooting Procedures		
Fault	**Probable Causes**	**Corrective Action**
Delayed Interlock Open	Delayed Interlock Jumper not properly installed or missing.	Check to ensure jumper is properly installed across the Delayed Interlock terminals D1 & D2.
	Device proving switch hooked to interlocks is not closed.	If there are 2 external wires on these terminals, check to see if an end switch for a proving device (such as a pump, louver, etc.) is tied to these interlocks. Ensure that the device and/or its end switch is functional. A jumper may be temporarily installed to test the interlock. Ensure that the time delay programmed into the controller is greater than the time for the end switch on the proving device to close.
High Temp Limit Control Open	Faulty Water temperature switch.	Test temperature switch to insure it trips at actual water temperature setting.
	Misadjusted limit	Ensure high temp limit switch is adjusted at least 10°F above the desired setpoint. See section 5.4.
High Temp Limit Control Open & High Water Temperature	Faulty vessel temperature sensor.	Using the resistance charts in Appendix B, measure the resistance of outlet temperature sensor and BTU sensor at a known water temperature.
	Unit in **Manual** mode.	If unit is in **Manual** mode, switch to **Auto** mode.
	Unit setpoint greater than Over Temperature switch setpoint.	Check setpoint of unit and setpoint of Temperature switch; Ensure temperature switch is set higher than unit setpoint.
	System flow rate changes faster than unit can respond.	If variable flow system, monitor flow changes to ensure rate of change is not faster than what the unit can respond to.
	See High Temp Limit Control Open.	See High Temp Limit Control Open.
	Temp High Limit setting too low.	Check Temp High Limit setting.
	Incorrect PID settings.	Check PID settings. If the settings have been changed, record the current readings then reset to default values.
Remote Interlock Open	Remote Interlock jumper not installed or removed.	Check for a jumper properly installed across the interlock terminals R1 & R2.
	Energy Management System does not have unit enabled.	If there are two external wires on these terminals check any Energy Management system to see if they have the units disabled (a jumper may be temporarily installed to see if the interlock circuit is functioning).
Secondary Low Water Level	Device proving switch hooked to interlocks is not closed.	Check that proving switch for any device hooked to the interlock circuit is closing and that the device is operational.
	Insufficient water level in system.	Check system for sufficient water level.
	Defective water level probe.	Check continuity of probe end to the shell, change probe if there is no continuity.
Low Water Level	Insufficient water level.	Check system for sufficient water level.
	Defective water level circuitry.	Test water level circuitry using the Low Water **TEST** and **RESET** buttons on the Controller's front panel. Replace water level circuitry if it does not respond.
	Defective water level probe.	Check continuity of probe end to the shell, change probe if there is no continuity.
OAT Sensor Fault	Loose or broken wiring.	Inspect Outdoor Tempe sensor for loose/broken wiring.
	Defective Sensor.	Check sensor resistance is within specification.
	Incorrect Sensor.	Ensure that correct sensor is installed.

Boiler Troubleshooting Procedures		
Remote Setpoint Signal Fault	Remote setpoint signal not present: • Not yet installed. • Wrong polarity. • Signal defective at source.	Check I/O Board to ensure signal is hooked up. • Hook up if not installed. • If installed, check polarity. • Measure signal level.
	Broken or loose wiring	Check continuity of wiring between source and unit.
	Signal is not isolated (floating) if 4 to 20 mA.	Check signal at source to ensure it is isolated.
	Edge Controller signal type selection switches not set for correct signal type (voltage or current).	Check DIP switch on MCB board to ensure it is set correctly for the type of signal being sent. Check control signal type set in the **Remote Signal** settings.

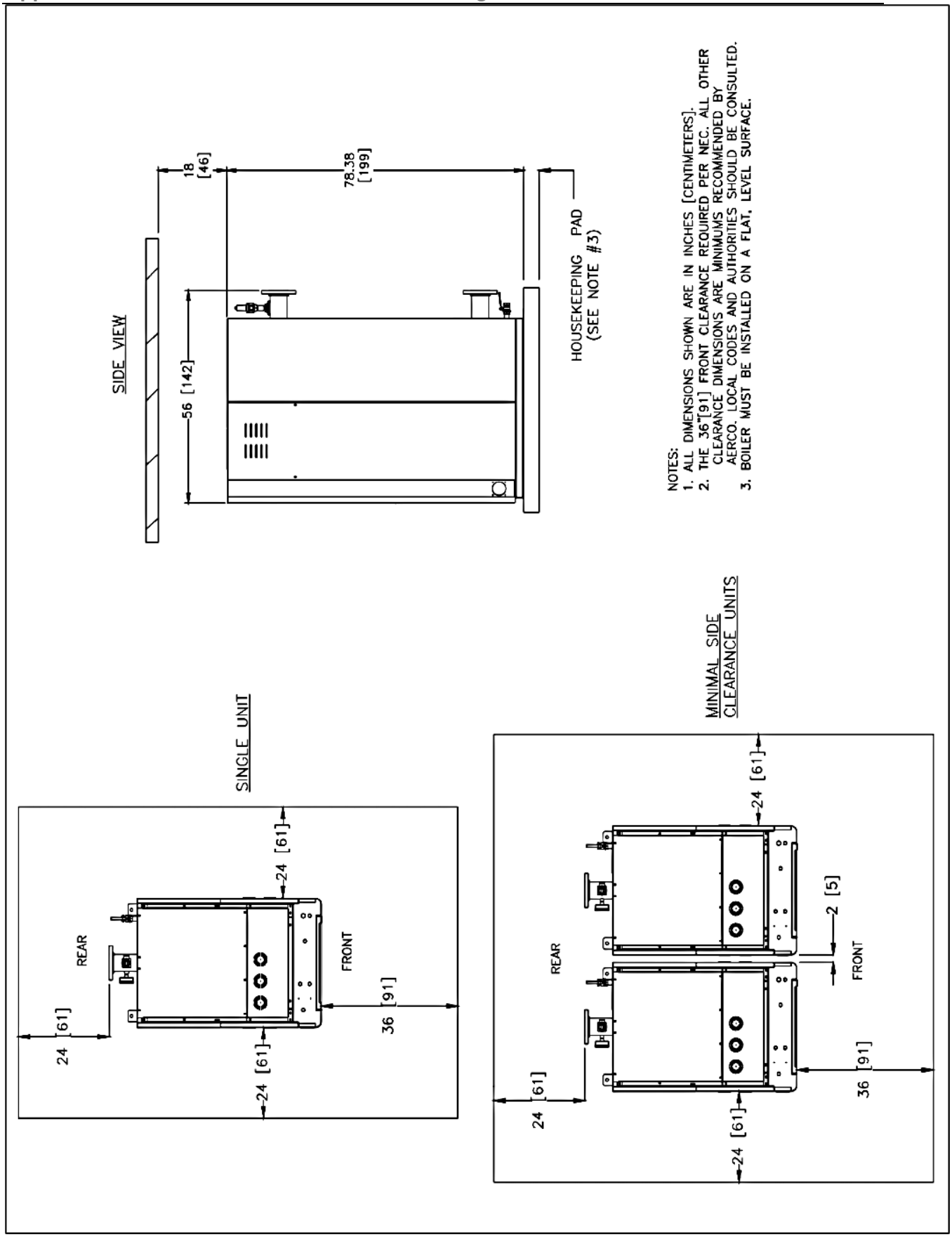
8.1 Additional Faults Without Specific Fault Messages

PT-1000 Temperature Sensor Resistance Chart		
Fault	**Probable Causes**	**Corrective Action**
Burned or discolored wires	Loose connections	Tighten all connections. If charred, replace wire with wire of same type and size.
	Dirty or pitted contactor points	Remove contactor points and inspect. If dirty, clean with emery paper. CAUTION: Point must remain flat. If pitted or burned, contactor points must be replaced.
Blown fuses	Loose connection.	Check all connections for tightness.
	Defective element	Check ohm resistance in electric elements. Replace if necessary.
High or low voltage	Local Utility	Check with local utility.
High or low amperage	High or low voltage	Check with local utility
	Defective Element	Check ohm resistance in electric elements. Replace if necessary.
Wire burned or melted at element	Loose connections	Tighten connection and replace wire with same type and size.
	Water leaking on elements	Isolate leaking water and repair. Replace wire with same type and size.

APPENDIX A: DIMENSIONAL AND CLEARANCE DRAWINGS



Benchmark E 216-684 Dimension Drawing AP-A-1095 rev B



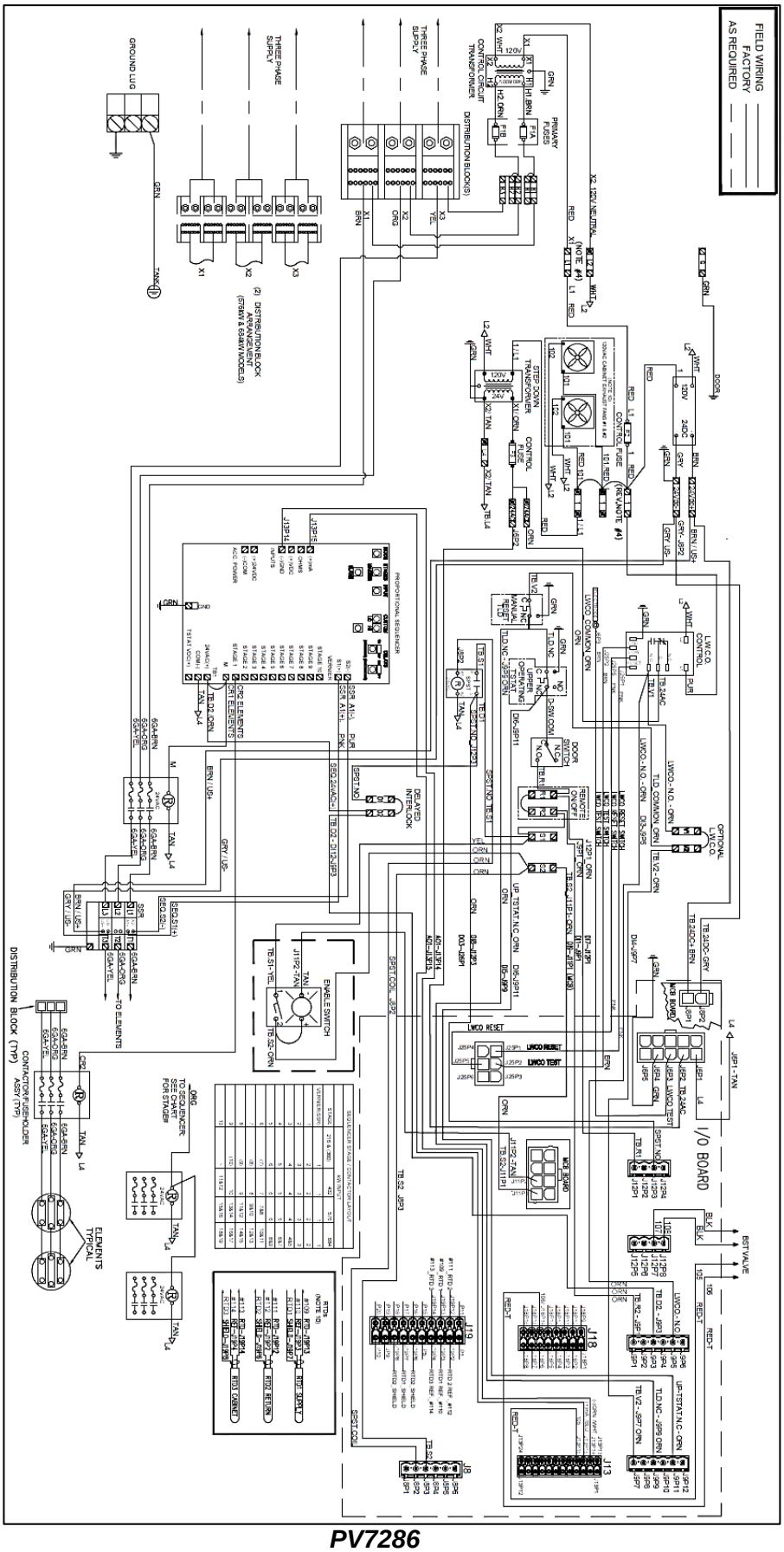
Benchmark E 216-684 Zero-Side Clearance Drawing SD-A-1341 rev B

APPENDIX B: SENSOR RESISTANCE CHARTS

Benchmark -E units have PT-1000 temperature sensors by default.

PT-1000 Temperature Sensor Resistance Chart		
Temperature		Sensor Resistance (Ohms)
°F	°C	PT-1000
-40	-40.0	843
-30	-34.4	865
-20	-28.9	887
-10	-23.3	908
0	-17.8	930
10	-12.2	952
20	-6.7	974
30	-1.1	996
40	4.4	1017
50	10.0	1039
60	15.6	1061
70	21.1	1082
80	26.7	1104
90	32.2	1125
100	37.8	1147
110	43.3	1168
120	48.9	1190
130	54.4	1211
140	60.0	1232
150	65.6	1254
160	71.1	1275
170	76.7	1296
180	82.2	1317
190	87.8	1339
200	93.3	1360
210	98.9	1381
212	100.0	1385
220	104.4	1402
230	110.0	1423
240	115.6	1444
250	121.1	1465

APPENDIX C: WIRING DIAGRAM



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